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APRIL, 1930

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Snake Stories
The Biology Course
Experimental Mathematics
Chemistry Demonstrations
Does the Ether Drift
April Eclipses

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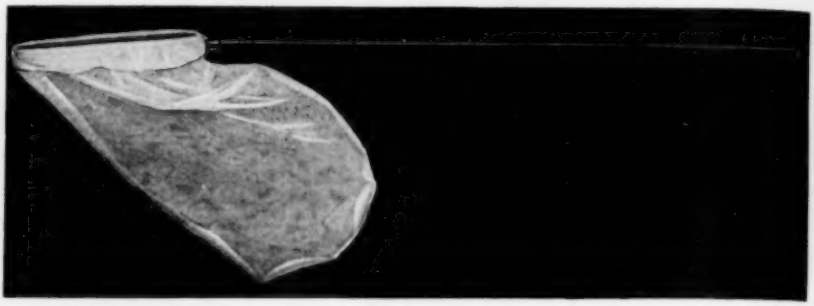

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SCHOOL SCIENCE AND MATHEMATICS

VOL. XXX NO. 4 APRIL, 1930 WHOLE NO. 258

OXIDATION—REDUCTION DEMONSTRATIONS.

BY ARTHUR HAUT,

James Monroe High School, New York City, N. Y.

In a previous article[1] the author outlined a method of teaching oxidation—reduction on the basis of electron transference. From his experience the author has found that average students just starting the study of chemistry can easily be taught facility in detecting oxidation and reduction actions of any kind and to tell at a glance how many electrons have been transferred from the reducing to the oxidizing agent. The author also outlined in this article a series of lessons showing exactly how this is done at his school.

At the James Monroe High School the electron theory is constantly used as the basis for explaining reactions and it is needless to say that the theory is accompanied by several experiments to show that it is founded on facts. There are many such experiments most of which make use of two solutions connected by a salt bridge, wire and galvanometer. The author will attempt to describe a group of these experiments.

1. *The Action of Zinc and Sulphuric Acid.*

Referring to the accompanying diagram (fig. 1) the left hand beaker contains a strip of zinc, while in the right hand one is dilute sulphuric acid. The salt bridge contains a solution of sodium chloride as also does the left hand beaker. Without the wire nothing occurs but when the wire is connected bubbles which prove to be hydrogen arise from the platinum foil in the acid. If the sensitive galvanometer is now inserted a deflection

[1] SCHOOL SCIENCE AND MATHEMATICS, December, 1929, p. 962.

shows that electrons are moving producing an electric current. The students are then shown, from the equation, just how and where the transfer took place.

$$Zn^{\circ} + H^{+}{}_{2}SO_{4} = \rightarrow Zn^{++}SO_{4} = + H_{2}^{\circ}$$

$$Zn - 2e \rightarrow Zn^{++}$$

$$2H^{+} + 2e \rightarrow H_{2}^{\circ}$$

The net effect then was to transfer electrons from the zinc to the hydrogen i. e. electrons move from the Zn strip in the left beaker along the wire to the hydrogen ion of the acid in the right hand beaker.

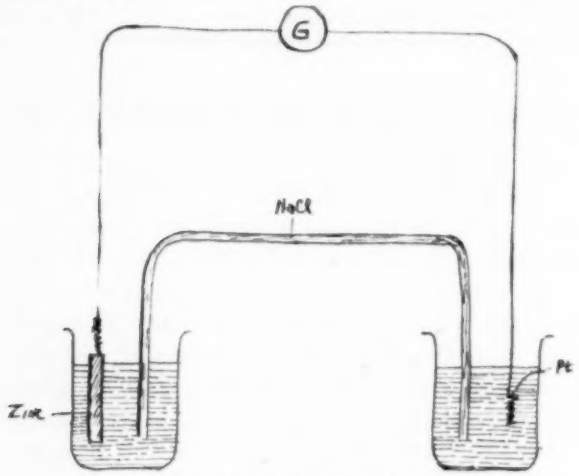


FIG. 1—A SALT BRIDGE.

It might be noted in this connection that hydrogen could be liberated in this manner if the zinc and sulphuric acid were in distant cities bordering on the same body of water which would act as a salt bridge if a telegraph wire were brought from one city to the other.

Other active metals can be substituted for the zinc, and hydrochloric acid used instead of sulphuric. A study of the metals from the standpoint of activity could very well be induced from this experiment but that is not the immediate purpose now.

This particular reaction furnishes a convenient introduction because the student studied it in connection with hydrogen.

The point to be emphasized here and also in the other experiments is that chemical change is in reality a transfer of those minute particles we call electrons. Solutions do not actually have to be in contact if electron transfer can take place by another method.

2. *The Reduction of Iron Salts.*

A similar apparatus is used as in the first case. The left hand beaker contains a potassium iodide starch solution and the right hand beaker a normal ferric chloride solution. In this experiment a platinum wire is attached to the copper terminal on the left side and this wire is inserted in a test tube as shown in figure 2. The purpose of this is to concentrate the blue color which will develop when the wire is attached.

$$\overset{+++\ -}{2FeCl_3} + \overset{+\ -}{2KI} \rightarrow \overset{++\ -}{2FeCl_2} + \overset{\circ}{I_2} + \overset{+\ -}{2KCl}$$

$$2Fe^{+++} + 2e \rightarrow 2Fe^{++}$$

$$2I^- - 2e \rightarrow 2I^\circ$$

The electron transfer was from the iodine to the iron of the ferric chloride or from the left hand beaker to the right, as the galvanometer will show.

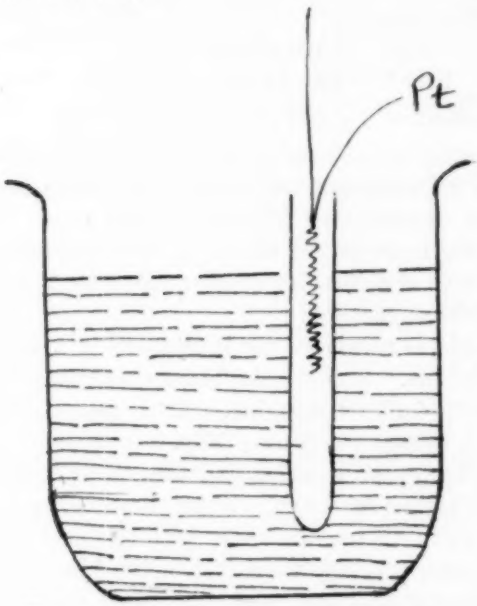


FIG. 2—SMALL TEST TUBE IN BEAKER.

This experiment, we find, is best demonstrated at the time iron salts are discussed although it is shown sometimes even at the initial discussion of oxidation in the first semester.

It is necessary, however, for complete understanding to show the pupil what happens when ferric chloride reacts with potassium iodide when both solutions are mixed in the presence of starch. He knows what should happen and now he learns that

it isn't necessary to bring the two into contact but simply to transfer the electron, again emphasizing the idea of chemical action as depending on this transference.

3. *The Oxidation of Iron Salts.*

In this experiment, the left hand beaker contains a solution of ferrous sulphate with some sodium thiocyanate, the right hand beaker potassium permanganate. The platinum terminal on the left side dips into a test tube containing a solution of sodium thiocyanate. When the wire is connected a red color develops around the platinum electrode showing the presence of the ferric ion.

As in the second case, it is essential to show the class what happens when the two solutions are mixed.

$$2KMnO_4+8H_2SO_4+10FeSO_4\rightarrow K_2SO_4+2MnSO_4+8H_2O+5Fe_2(SO_4)_3$$

$$2Mn^{+7}+10e\rightarrow 2Mn^{++}$$

$$10Fe^{++}-10e\rightarrow 10Fe^{+++}$$

4. *The Reduction of Silver Ion.*

The following experiment was developed at James Monroe High School as a regular laboratory experiment and is shortly to appear in "Laboratory Manual for Beginning Chemistry."[2]

It is nothing more or less than a practical application of electron transfer to the cleaning of silverware by the now familiar strip of aluminum method.

A silver coin is tarnished by immersion in a solution of ammonium sulphide. It is washed and dried and shows a good black deposit of silver sulphide. It is placed ln the bottom of a 100 c. c. beaker containing 50 c. c. of a solution of sodium chloride. The liquid is boiled and the vapor tested for hydrogen sulphide shows no result. When, however, a strip of aluminum is allowed to come in contact with the silver coin evolution of the hydrogen sulphide takes place, the black silver sulphide starts to dissolve and can easily be wiped off the coin with a dry cloth. The explanation is that aluminum being higher in the electromotive series loses electrons more easily than the silver and is positive with respect to the silver. The net effect is to change a silver ion to a silver atom by the gain of an electron which comes originally from the aluminum i. e.

$$3Ag^{+}+3e\rightarrow 3Ag^{\circ}$$

$$Al^{\circ}-3e\rightarrow Al^{+++}$$

[2]Fletcher, Harrow & Smith—American Book Co.

Just what the mechanism of the reaction is can be explained in several ways. The aluminum and silver may form a small couple and electrolyze the water. The hygrogen attacks the silver sulphide and silver and hydrogen sulphide are formed.

$$Ag_2S + H_2 \rightarrow H_2S + 2Ag$$

This experiment when given at the end of the course acts as an excellent review of:

(a) electron transference, oxidation, and reduction
(b) electrochemical series
(c) test for sulphide
(d) electrolysis

The reader can easily see the possibilities in such experiments. The salt bridge type furnishes a convenient method of showing electron transference for almost all reactions. The author has not experimented yet with the following, but he expects that these reactions should give good results:

1. Potassium permanganate and hydrogen sulphide.
2. Potassium permanganate and sulphur dioxide.
3. Ferrous sulphate and nitric acid or hydrogen peroxide.
4. Copper and nitric acid, etc.

WHAT SHOULD BE THE PREREQUISITES FOR THE STUDY OF BIOLOGY?

By Miss Nellie Cook,
Spokane, Wash.

I am not strictly in sympathy with teaching Biology as generally taught. We have a year of Botany and a year of Zoology following the required first year subject of general Science. It more nearly gives the student the proper attitude toward scientific thinking, and method of work. Even that is a mere beginning as the students say themselves.

There are some fundamentals I insist on however. Wherever possible do not destroy the joy of a student in self-discovery. This is emphasized in much field work. Give some credit for this self-discovery. That is, give grades for it, if grades are given. Over emphasize if necessary a well kept note book. Observe rigidly, proper margins—use of proper classification in headings—proper paragraphing, fine types of English in expression. I deplore the use of filling in blanks or underlining expressions which are mimeographed. It makes the work too much teacher made, rather than student made. Every child should develop creative work. Have frequent reports on good books for outside reading, lectures or radiograms. We keep a daily log book, which affords much of interest to alumni in the subject. I find very few students who do not want to work, and work hard.

I have all sorts of plants everywhere, grouping them into habitat sketches. In the fall I collect seed pods for thicket groups, water groups, hillised groups, and geum and forest groups. At present we have miniature desert groups, groups representing a region known as Garden Springs, another known as Hollywood, another known as Indian Canyon. Fresh material is obtained each week to keep up the collecting spirit.

BETTER DEMONSTRATIONS IN PHYSICS.[1]

By N. HENRY BLACK,
Harvard University, Cambridge, Mass.

In recent years our attention has been called again and again through various investigations to the undoubted educational value of class experiments. In our enthusiasm some years ago for laboratory experiments we doubtless swung too far to that side and neglected the older form of instruction, namely, lecture-table demonstrations. Today we are swinging back, and probably our demonstrations are less formal than they used to be and more in the nature of a coöperative enterprise between teacher and class. I feel very strongly that we need more and better demonstrations in physics.

Why do demonstrations.

We need them first in order to arouse interest in the subject. Our laboratory experiments are necessarily restricted to the quantitative aspects of the subject which lend themselves to measurement. But there are many other topics which while we may not yet be able to measure them, we should like to illustrate in a concrete form by means of an experiment. Surely the experience of all of us leads us to believe that our classes never tire of seeing good demonstrations. We also find that the classroom demonstration helps enormously to make things clear. The concepts in physics are sometimes so difficult for the young to grasp, and often even for the older students, that we need to employ every means available to help them visualize the ideas involved. Finally, I feel that the demonstration experiment is a great saver of time. The teacher can review many topics by performing the right kind of demonstrations followed up by searching questions which are often suggested by the students themselves.

Why don't we do more demonstrations.

The question naturally arises: If these demonstrations in physics are so necessary to arouse the interest of the class, to clear up the hard things, and to save the time of the class and the instructor, why do we not do more of them? I think any inspector of physics teaching in our schools at large will agree that this phase of our teaching

[1]Summary of a talk delivered before the Physics Section of the Central Association of Science and Mathematics Teachers on November 29, 1929, at the University of Chicago.

today is sorely neglected. In the first place, if you look at the equipment of the smaller high schools, and of some large schools, too, you will find a lamentable lack of suitable apparatus and equipment for demonstrations in physics. Many pieces of the older apparatus are merely toys, and these often have got out of repair and do not work. Then too, the apparatus is often so flimsy that even when it is in repair it needs many apologies from the teacher. The apparatus is often so small that the boys and girls in the back seats do not see what is really happening. I wish we could here get every member of this section to use his influence with the apparatus makers and dealers to give us *better*, *bigger*, and *simpler* demonstration apparatus.

But even when there is equipment, many a school has all too few classroom demonstrations in physics. This is due to the heavy schedule of teaching which our teachers have to carry. It is only very occasionally that a headmaster realizes that the science teacher can not teach so many periods a week as the mathematics or language teacher, because of the fact that he must have time to prepare his demonstrations and prepare for laboratory experiments. I see no way out of it except to adopt the system which is quite common abroad, of having trained assistants who, after years of experience, learn the routine of setting up the apparatus and making sure that it will work. Such assistance need not be very expensive, and it saves the time of the more highly paid instructors.

There is one more reason, I think, why we do not perform more classroom demonstrations, and here I must be very frank and say that I believe it comes from the timidity and lack of experience of the teachers of physics. This means that many of us might well put in more hours of patient experimenting after school, on holidays, and during our summer vacations, learning the technique of classroom demonstration. That confidence which comes after one has lived with the apparatus is bound to react on the class and to give the pupils assurance that the experiments will work.

How shall we go to work to improve our demonstrations.

What can I say that will show you how we can secure more and better demonstrations in physics? Many years ago I heard Professor Millikan at the N. E. A. convention

in Cleveland plead for better and more demonstrations in physics. He not only plead orally but he actually did experiments before the teachers. The conditions under which he had to work were surely not very favorable. The meeting of the Science Section was held in the vestry of a church, and I remember that the apparatus was unpacked somewhere in the basement and brought up in washtubs, but this did not daunt Professor Millikan. Let me urge you to study the various textbooks for directions for these demonstration experiments. I well remember when using Millikan and Gale's first edition of their elementary textbook that I set myself the task of performing with my class of students in one year every single classroom demonstration that was outlined in the book. In the course of this procedure I became convinced that those demonstrations were put into the book in order to be used by the teacher and not just to be read about by the students. I must also admit that I then and there acquired a confidence in handling of apparatus which has stood me in good stead.

Therefore let me urge you first to examine all the modern high school textbooks in physics for suggestions as to practical classroom demonstrations. Second, I would urge you to study the recent catalogs of our apparatus dealers, and then those of such foreign dealers as E. Leybold's Nachfolger in Cologne and Max Kohl in Chemnitz. You will find many suggestions about pieces of apparatus which can be improvised if you do not have the funds to buy them. Also, in the descriptions of apparatus you will find hints as to use, purpose, and method of handling. Lastly, I shall have to be very frank and speak to you from my recent experience in looking over certain small high schools in the Commonwealth of Massachusetts. I feel that this crying need for better demonstrations demands first of all a campaign of cleaning up and repairing whatever apparatus we now have that is still good, and of scrapping the rest. Perhaps conditions in your high schools are not so bad as in some that I visited in Massachusetts. But if the shoe fits, do put it on at once and do some drastic housecleaning.

Six worthwhile demonstrations.

Now I should like to show you some demonstrations which I have recently found to be particularly useful in my own teaching of physics to a class of beginners in college physics.

The *first* experiment consists of the projection of the so-called gold leaf (really aluminum leaf) in the electroscope as a shadow. In this experiment we use a small arc lamp on a 110-volt d. c. line which draws about 5 amperes, and with no lenses we simply project the shadow on the screen. (Fig. 1.) We can make it as large as is feasible and in this way hold the attention of the class because they can all see the action of the leaf.

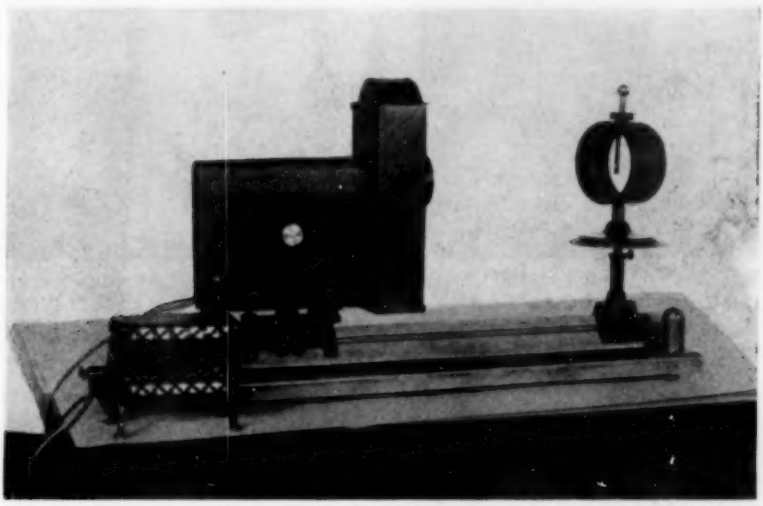


FIG. 1. SHADOW OF GOLD-LEAF ELECTROSCOPE. A RIGHT-ANGLE CARBON-ARC LAMP (5 AMP.) WITHOUT CONDENSER AND ELECTROSCOPE ON STAND.

In my *second* experiment I show the vibrations of a violin string. Please notice that I have the ordinary projection lantern, an arc lamp, and a condensing lens. In front of this I place a vertical metal screen with a narrow vertical slit. Across this slit I set up a wooden frame with a horizontal string vibrating up and down. But instead of the ordinary projection lens I use a series of 5 lenses arranged in a disk so that one after another is whirled into position and projects the picture of the violin string as it vibrates across the slit. The effect of these successive images thrown on the screen is to give the eye an image of a wavy line. (Fig. 2.) If we pluck the string near one end, we produce not only this fundamental wave but also the overtones, which can be seen as little wavelets superposed on the fundamental wave.

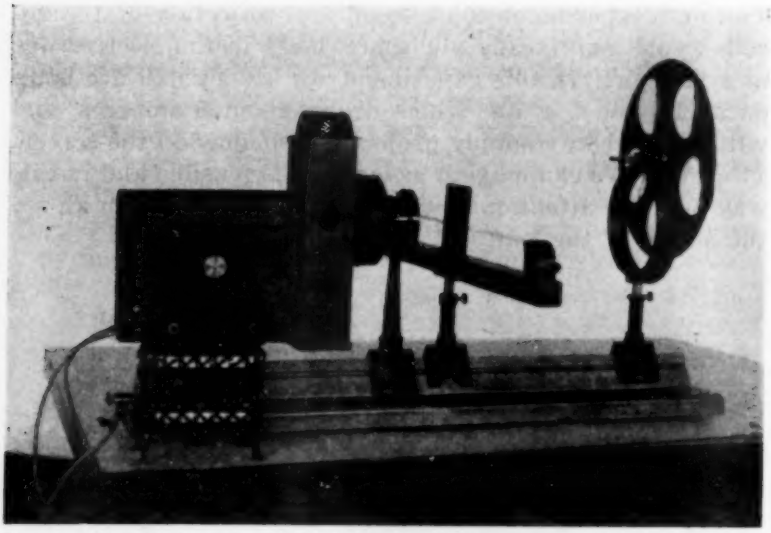


FIG. 2. VIBRATIONS OF A VIOLIN STRING, SHOWING THE FUNDAMENTAL AND OVERTONES. ARC LAMP, CONDENSER, STRING, SLIT AND ROTATING OBJECTIVE LENSES.

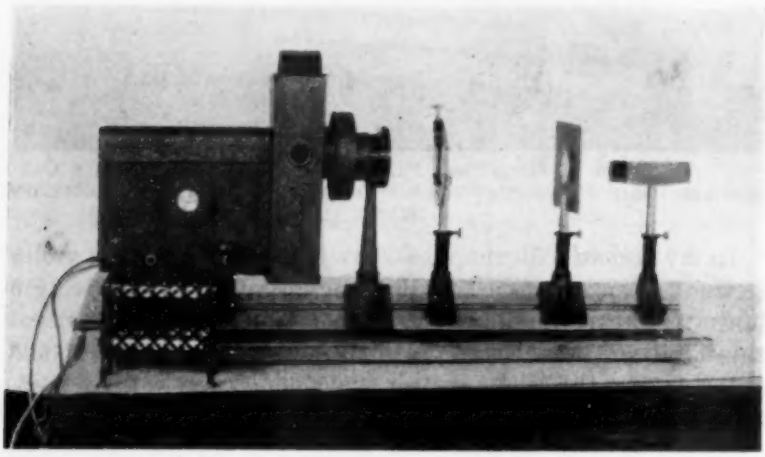


FIG. 3. PROJECTION OF CONTINUOUS SPECTRUM. ARC LAMP, CONDENSER, SLIT, CONVERGING LENS, AND SET OF 5 PRISMS OF DIRECT-VISION SPECTROSCOPE.

My *third* experiment is the production of a continuous spectrum. Here I am using the same arc lamp, again with a condensing lens. Next comes an adjustable slit about a millimeter wide and then a train of 5 prisms such as is used in a direct-vision spectroscope. These pieces of apparatus are all set on the standard triangular optical bench devised

by Zeiss. This apparatus enables me to get more dispersion and to project the spectrum directly on the screen. But between slit and prisms I must insert a converging lens (f=20 cm.) at such a position that the slit and the white screen are conjugate foci. When this is done we have a very clean-cut spectrum. (Fig. 3.) With it one can do all the usual experiments with different colored glass plates showing the absorption of light by transparent media and with the different colored yarns showing the reflection of light by different colored fabrics.

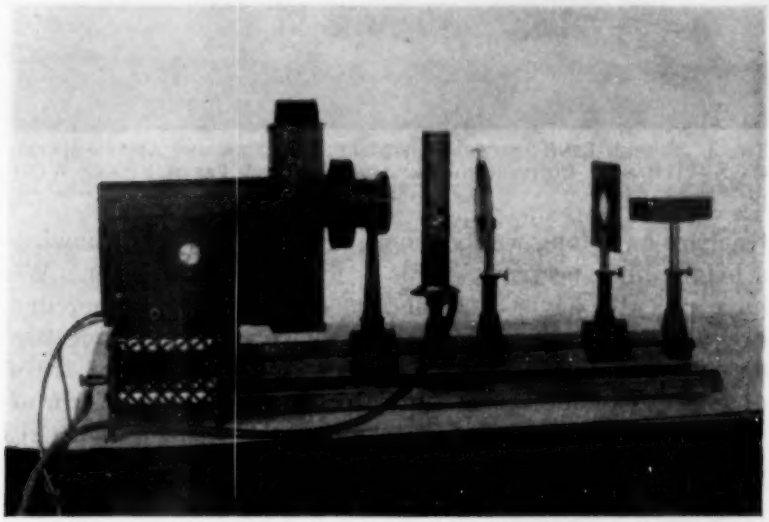


FIG. 4. SODIUM ABSORPTION SPECTRUM. ARC LAMP, CONDENSER. BUNSEN BURNER WITH METAL CHIMNEY, SLIT, CONVERGING LENS, AND TRAIN OF 5 PRISMS.

Now with this apparatus in place I will do my *fourth* experiment, which is to show the absorption lines due to sodium vapor. Here I am going to introduce between the condenser and slit a Bunsen burner which is provided with a small metal chimney and a little basket supported inside. I shall place in this basket a drop of metallic sodium about as large as a small pea and very soon shall have an intense sodium flame. The white light from the carbon arc passing through the yellow colored vapor of sodium has that wave length absorbed and so our spectrum shows a black line (or rather two black lines), where the sodium would have been. (Fig. 4.)

In the study of the spectrum both physics and chemistry

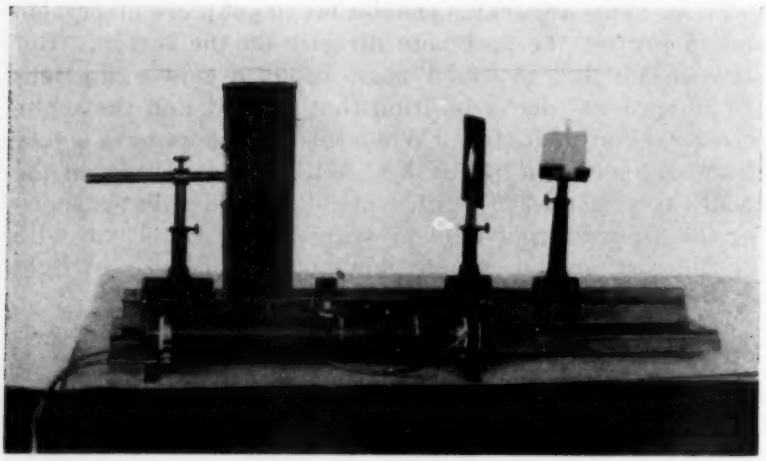


FIG. 5. BRIGHT-LINE SPECTRUM OF MERCURY. MERCURY ARC IN METAL CASE WITH SLIT, CONVERGING LENS, AND BOTTLE PRISM FILLED WITH C_6H_5Cl.

teachers have long wanted some convenient way of showing a bright line spectrum. This is my *fifth* experiment. We have recently devised an inexpensive home-made mercury arc which can be used instead of the carbon arc. Since we do not want to absorb much light with a direct-vision train of prisms, we shall use a single prism made in the form of a triangular bottle filled with monochlor benzol (C_6H_5Cl). In this way we shall be able to project with the same ap-

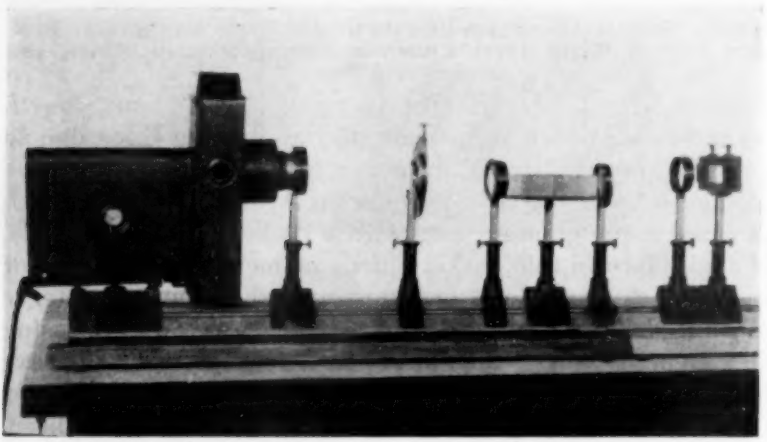


FIG. 6. CHAFFEE'S COLOR MIXER. ARC LAMP, CONDENSER, SLIT, LENS ($F=+12.5$ cm.). TRAIN OF 5 PRISMS, LENS ($F=+33.0$ cm.) WITH DIAPHRAGM, LENS ($F=+12.5$ cm.) AND 2 SLIDING 5° PRISMS.

paratus that we used for the continuous spectrum, but substituting the mercury arc for the carbon arc, and omitting the condensing lens, and using only a slit, one converging lens and the bottle prism. (Fig. 5.) The three bright lines in the visible spectrum are clearly seen, and with the fluorescent screen of the fluoroscope two more beyond the violet are clearly visible.

My *sixth* and *last* experiment was suggested to me by Professor Chaffee of our laboratory at Harvard to show the various effects of mixing colors. Here we use the arc lamp, condenser and slit, and a double convex lens; then a direct-vision train of 5 prisms with a small hole in a diaphragm, and finally a converging lens. This apparatus set up on the optical bench gives us, of course, a white disk due to the bringing together of the prismatic colors by the converging lens. But if we insert two little prisms with refracting angles of about 5° and cut so that the dihedral angles are about 30° with the horizontal, we are able to throw up and out a portion of the spectrum on either side. Here we have three colored disks which can be made to overlap and which can be varied in the colors used by sliding the prisms across the field of view. (Fig. 6.)

The National Council of Supervisors of Nature Study and Gardening (name now changed to the National Council of Supervisors of Elementary Science), met Saturday, Feb. 22, 1930, in the Municipal Auditorium at Atlantic City, N. J.

During the morning session, which was devoted to a symposium on "Research and Experimental Work in Elementary Science," most helpful and practical papers were presented by Dr. Ernest Horn, Dr. Ned H. Dearborn and Miss Florence Billig.

The forty members who attended the noon luncheon received greetings from the American Nature Study Society brought by Mrs. Bertha Chapman Cady, and enjoyed the informal round table discussion.

"New Courses of Study in Elementary Science" was the subject of the afternoon session. Courses of study from Grand Rapids, Mich., New Jersey, Cleveland, O., Pittsburgh, Pa., and New York State were reported upon and discussed to the mutual benefit of all who are struggling with the same problem.

To the untiring efforts of the retiring officers and program chairman is due a great deal of credit for this splendid meeting: Miss Lillian Hethershaw of Drake University, Des Moines, Ia., President; Miss LaVerne Argabright, W. S. T. C., Kalamazoo, Mich., Secretary-Treasurer and Dr. Chas. Pieper, New York University, Program Chairman.

The incoming officers are: President, Gerald S. Craig, Columbia University; Vice President, James M. McArthur, New Orleans Normal, New Orleans, La.; Secretary-Treasurer, Helen Dolman, M. S. N. C., Ypsilanti, Mich.

THE CONTENT OF THE BIOLOGY COURSE[1]

By ALFRED C. KINSEY,
Indiana University, Bloomington, Ind.

Among the subjects of the high school curriculum, there is probably none that has had more varied evaluation and treatment than the introductory course in general biology. Biology has been credited[2] with "serving a greater number of the ends of education than any other single subject" in our high schools. Within a twelvemonth of this judgment, biology had been criticized[3] as "a survival of an early stage in the pedagogy of the subject [which] has no place in a modern educational scheme." All of you must have heard our present unit course characterized as "botany taught by a zoölogist."

This diversity in the evaluation of our subject is matched by—and probably finds some explanation in—the diversity of the materials which are actually included in biology as it is taught today. Inquiry among high school teachers indicates that we are drilling our students in the details of certain morphologic types, or that we are trying to give them a general introduction to all the plants and animals with which they may come in contact; that we are teaching textbook facts as so much Latin grammar and sentences to be memorized and dissected; or that we are emphasizing and using demonstrations, laboratory, independent projects, or field work according to our varying dispositions and indispositions, or, incidentally, our conception of the importance of the so-called inductive method of education; that we are, in short, not quite clear whether Mendelian heredity or the physiologic effects of cigarettes and coffee, whether crayfish endopodites, exopodites, and basipodites, or artificial resuscitation, the concept of evolution, or the daily use of the toothbrush are the more important materials to present the average future citizens who sit in our classrooms.

An examination of current textbooks and state syllabi similarly shows (1) that we are undecided whether our introductory course should involve a half-year of botany followed by a half-year of zoölogy, or a unit and synthetic

[1]This paper was presented at the Biological Conference. Reprinted from the Journal of the Michigan Schoolmasters' Club, 1929.
[2]Report of Biology Teachers of Chicago, 1920. SCHOOL SCIENCE AND MATHEMATICS, XX, 642.
[3]G. E. Nichols, Science, L (1919), 517.

course concerned with generalizations applicable to all organisms; (2) that some teachers prefer the type course, with its detailed studies of a limited number of species supposedly illustrative of the major phyla and classes, while others prefer to emphasize principles for which a host of common plants and animals may be used in illustration; (3) that some of our courses are almost exclusively morphology and physiology, while others include a summary of another half-dozen sub-sciences; and finally (4) that we are uncertain whether a so-called pure science or an applied science, particularly in its bearing on human hygiene and sanitation, is more profitable for an elementary student.

One wonders if some resolution of such conflicting opinions may not come through a redefinition of our objectives and a revaluation of the extent to which future men and women may fairly be concerned with the materials of our science. While we question the wisdom of standardizing the content of the course, we are inclined to believe that we may find common aims toward which we may adapt the varying materials that best satisfy our individual needs.

We are concerned, as teachers of the introductory biology course, with high school boys and girls, college men and women, who will go into nearly every walk and profession in life except that of teaching or research in biology. There can be no justification for distorting our program for the one student, among many hundreds or thousands, who will engage in biology as a profession. We should be concerned with the content of the course which will best serve the average future citizen, which will awaken his interest in the living world in which he lives, and equip him with the scientific method for interpreting that world.

These, I take it, are the goals of our program. These are the standards against which we may measure the teaching value of the specific materials in our curriculum. If there are other goals which we, as biology teachers, are attempting to accomplish, they are but special aspects of these two aims. If there are a hundred and one specific facts that we wish to give our students, they can be of importance only because they contribute to these two ends: to interest the student in the world in which he lives, and to equip him with the scientific method for interpreting that world.

For the accomplishment of these ends, ours are the resources of the whole living world. The green of the hills and the fields, the flash of the bird's wing, the depth of the flower, the vibrant hum of the midsummer noon, the breath of the evening garden, the crashing forms of the midwinter storm—these are but chapters in the drama we call life. The growing crops or the marketed product, the health of the mountain forest or the city waste spot, the prosperity of bug, fungus or germ—these are affairs with which every man is properly concerned. The stuff of which we are made —this is material of our science. Among all things, in all curricula, none may have as intimate a concern for every man and woman. Ours is the task, the privilege, of introducing youth to the glory of this living world that is about us. If we wisely choose from this store of material, we can not fail to interest these pulsing embodiments of life which are the youths who come to us.

The Morphology Type Course

Whereupon—do we thrust their noses into dead cats and dried fungi; cram their heads with polysyllabic Greek and Latin terms for nerves and muscles of obscure Arthropods; and drill them on calories, germs, narcotics, and the other phobias from the blue book of social hygiene? Or do we have them cultivate an intimate acquaintance with the natural history of living things about them, with the ways of movement and feeding and mating of familiar animals, and the places and the conditions of growth, flowering, and fruiting of familiar plants, and the endlessly involved interrelations of all living organisms?

This is the essence of the most fundamental problem facing us as we shape our biology program today. In more circumspect terms, we must decide whether morphology and human hygiene represent the best introduction to the science of life, or whether the more typically natural history aspects of our science provide a more certain means of serving the student. This, of all problems of content, is the chief cause of the diversity in our elementary texts and classroom treatment of the day. There are college books on the market that include practically nothing but plant and animal morphology. There are high school texts in which 70 per cent of the material is morphology and human hy-

giene. There are other texts and an increasing number of teachers who, while giving due attention to the fundamentals of morphology and physiology, are devoting 70 per cent of their attention to problems with living organisms.

For half a century in our classrooms, and for a longer period in our research, we accepted morphology as the foundation of our science. Indeed, for much of that time morphology came near constituting all of our science. The study of form and structure had developed as a reaction to the overemphasis on systematic botany and zoölogy in the eighteenth century, and the brilliant contributions of comparative anatomy, histology, cytology, embryology, and the other morphologic sciences must demand the respect of every one conversant with modern developments. As a method of scientific research, as a means of solution of many fundamental problems, I pay homage to the long record of accomplishment and will admit the continued importance of the sciences of plant and animal morphology. But as meat and drink for beginning students, as a means of interesting future citizens in this world, or even as an inevitable foundation for advanced work in botany or zoölogy, I will not concede it as happily adapted as a half-dozen of the other sciences that constitute modern biology.

The chief contribution of morphology to the teaching of biologic science was the type course, first conceived a half-century ago by Thomas Henry Huxley. In the study of the form and structure of a selected set of types, we were led to believe we introduced all of the general principles with which young students might properly be concerned. We used crayfish to illustrate structural adaptations; we let flat worms stand for all parasites, frogs for vertebrate structure, and microscopic algae as an epitome of sex among organisms. However, it may be questioned whether elementary students ever perceived the principles as more than adjuncts to the study of structure; and it is certain that smelly structures are poor substitutes for the myriads of familiar organisms which properly constitute the first interest of most men. Instead of utilizing the living things in the pond or roadside ditch, we have been taking a microscopic bit of pond scum, magnifying it beyond all familiarity, compressing it out of all third dimension, inverting it

until it looks dizzy, spending an hour convincing the student that the real world must be observed through lenses, and spending the rest of the week developing his ability to make artistic reproductions of this far-fetched sample of reality.

And yet, we must admit the teaching convenience of this type course. Its materials are readily obtained, concrete for observation, and enduring as a source of individual occupation. As one of our prominent biologists has phrased it, in a criticism of "The Dry-Rot of Our Academic Biology"[4]: "We might regard it as a great handicap that we academic biologists, unlike our native woodchucks and muskrats, are compelled to be most active pedagogically during the annual glacial period, but our superior intelligence enables us to cope with that situation. Every autumn we lay in a few cans of soused dogfish and pickled sea cucumbers, coop up some guinea pigs, earthworms, cockroaches and fruit flies, throw in a bag of beans and several bales of hay for the botanist—and we are prepared for the worst. We can now proceed to disentangle and unreel the infinite and ineffable complexity of organic reality. We have more than enough for the purpose, for were we not all taught in our childhood by some old maid with ringlets that any little flower, or any little bug, for that matter, plucked from the crannied wall and held in the hand, is sufficient? When the neophyte becomes nauseated with the mess we have provided, we can encourage him and incidentally heighten our own prestige by telling him that he is learning to forecast and control the behavior of organic nature, that he may shortly be able to make real live homunculi and regulate their mating habits, and all the pishpash with which, since the Neolithic Age, other priests and other wizards have heartened their constituencies."

Human Hygiene

The first considerable reaction to morphology as material for beginners developed within the secondary schools of our larger cities which, naturally enough, had especial occasion to appreciate the importance of such matters as human health and disease, public sanitation, and civic control of varied problems of economic biology. Within the first

[4] W. M. Wheeler, Science, LVII (1923), 63.

decade of the present century, American leadership pushed such applied sciences as forestry, entomology, ornithology, agriculture, aquiculture, and dietetics to the forefront of scientific endeavor, and the medical sciences received a new vision of the possibilities in public co-operation on problems of food supply, sanitation, disease control, and other aspects of human hygiene. To the half-botanical and half zoölogical biology course which had originated in the colleges and universities, the secondary schools added another section in physiology, which was primarily human hygiene. To the pedantic attitude of the research scientist who found no problem of scientific interest after its economic importance had once appeared, we reacted with characteristic American proficiency by passing laws requiring that human physiology constitute at least a third of the course, and elementary texts went so far as to build most or all of the curriculum about economic or civic biology.

For some attention to applied science, to economic aspects of ecology, and to the practice of human health, nothing need be written here in extenuation. For that form of the holier-than-thou attitude which supports the arrogance of pure science there seems no sound justification, for the complementary relation of the pure and applied science must be evident to everyone who has given unbiased attention to the question. Of the importance of human health as a source of happy existence and a prerequisite to any full appreciation of the glory of the living world, you must believe me insistent. If I question the preoccupation of too large a section of the biology course with problems of civic or economic import, I would still include every known application of a biologic principle that could be reached in a well-balanced program of general biology.

A working knowledge of human hygiene should be acquired by the grade school student. Several years before the high school biology course will reach him, a large portion of the material in hygiene should be, and can effectively be, given to young America. If our grade school curriculum does not make adequate provision unto this end, we, as science teachers, might properly concern ourselves with putting it into the grade schools. Where the boy and girl is getting it before he reaches the secondary school, what

excuse is there for the repetition of elementary hygiene in our biology course?

Again, I object to the use of our limited time in biology for disseminating propaganda on every conceivable fad and fashion that can be construed to concern human happiness. The attitude of the board of clergymen who rejected the biology text which included Darwin's portrait is not far removed from that of the biology teacher who rejected the book that had "nine chapters on insects and only twenty words on alcohol." In current texts and current curricula, I find extended exhortations on wasting foods in kitchens, on coffee, tea, cocaine, candy, tobacco, Keeley cures, ventilation, poisonous dusts in industry, accidents, fire-prevention, garbage disposal, artificial resuscitation, vegetarianism, whole chapters on vaccination, and the latest gospel on vitamins, pages on constipation, woolen underwear and Freudian complexes which leave one bewildered to know what is biology and what is first aid, dietetics, home economics, industrial management, civics, or ordinary politics. From a biology designed to interest future citizens in the living world about them, and calculated to introduce those citizens to a scientific method, we are at best directing their attention to a species of toothbrush biology suspiciously fortified with the trappings of articles of personal faith.

Natural History

But returning to our historical reckoning, it is evident that we are recovering our sense of proportion in such matters, and reshaping our biology syllabi to give such subjects as morphology and physiology, including human hygiene, a due place in a program in which no single aspect of biology distorts the fair proportions of the whole living world. While such a large city as Chicago, with its constant contacts with problems of hygiene, made its 1920 syllabus[5] chiefly economic biology, I am advised that the recently completed syllabus returns to a broadly natural history program. Even the urchin of the streets needs to know that there is an interesting world about him. The boy on the farm needs his eyes opened to something more than the economic significance of roots and bugs. Even every boy and girl in every corner of our land needs to obtain two

[5] School Science and Mathematics, XX, 642.

chief things from us: an interest in the world in which he lives, and an equipment of scientific method.

But lest I be misunderstood, let me hasten to assure you that I do not propose to specify very much beyond this mere generalization as to the content of this revised course. It is difficult for one who has already committed himself in a text on biology to persuade you that he believes there are several ways of accomplishing these ends of our program, but I would protest that I do not believe it desirable or possible to standardize the introductory course in any science which is expanding as rapidly as ours. I deeply mistrust the ability of biological supply houses to reduce the teaching of the science of life to a routine that will revolve without the inspiration of a teacher in constant contact with the seasonal progression of the living plants and animals that constitute one's local environment. I believe that the value of such pedagogical machinery as daily lesson plans and state syllabi is to be derived from their use as points of departure from which the individual teacher must depart as soon as the state of the science, the weather, or the student's health or interests have progressed beyond the point upon which the syllabus was established. Withal, I shall suggest only three items of content about which I feel more than usual conviction.

The first of these, the emphasis on the natural history of familiar organisms, I have already used as background and highlights of my criticism of other programs. With the pertinence of such materials most of you will agree, and with their interest for the student as many of you are already convinced. Only some of you will not like the phrase natural history. To some it will smack of old-fashioned or elementary stages in our science. To you, I plead that within two decades old-fashioned natural history has been builded into the modern sciences of taxonomy, ecology, distribution, and behavior. Some of you will agree with my good friends in the biological supply houses, who have spilled much ink, recently, to prove that the dissection of their products is sounder scientifically and more meet for young students than the newfangled sciences which are demanding the attention of research men. To you I reply that the elements of our new sciences are the simple natural history which long ago proved its worth as inspiration for

young biologists. I offer no new program, but a return to one of proved worth, re-established by modern developments in the best of research science.

My second specification is for a biology course that is a unit, a synthesized program which is neither botany nor zoölogy, nor half of one and half of the other, but a course dealing with phenomena and emphasizing the principles which are common to both worlds. I think to the boyhood day when I roamed the fields and hills in fine ignorance of the sharp distinction "they" would have had me make between botany and zoölogy. Between the plant and the bug that fed on it. Between the flower and the bee that came to it. Between the plant tumor and the insect that caused it. Between the immigrant weed and the immigrant worm. Between the green of the clover and the nitrogen factories on its roots and the beef of the cow in the pasture. As my studies have progressed, they have served to emphasize the similarities rather than the differences between plants and animals, and I still fail to see why the average boy, wandering the hills of this world, should be asked to be interested during this semester in nothing but the plants of the way, and to transfer his interests to the animals of that same path only after the school calendar has sufficiently revolved. It is with this in mind that I express some preference for a unit and synthetic biology.

Finally, I would urge that our introductory course present a balanced picture of reality, instead of more intensive study of a single aspect of science. For perhaps 95 per cent of our students, this is the only contact they will have with formal biology in the course of their school careers. It may be true that a review, or preview, of all aspects of our science offers a very thin smattering of things, and that there is much merit in having a single aspect of our subject thoroughly presented, but I hold for such a general introduction to the living world as will enable the student to understand the significances of the more special problems he may meet in advanced courses or along his everyday paths throughout life. As teachers we are guides. I propose that on our initial voyages we introduce the young tourists to something of every biologic sub-science, to a balanced natural history of familiar plants and animals, in-

stead of an intensive drill in any single aspect of the landscape.

I am reminded of that most instructive of rock records, that most inspiring of captured mountain ranges, the Grand Canyon of the Colorado of the West, and of the tourists who go to it. A few years ago it was said that 95 per cent of the travelers passing on the transcontinental roads within sixty miles of the Canyon never visited it. They are the folks who move through this living world without learning to see it. I am reminded of the guides who, like good biology teachers, must try to show the whole Canyon to the wayfarer who can tarry but a few days at the brink of the inexhaustible store of treasure. There may be guides, or research geologists, who, like some other biology teachers, believe that an introduction to the Canyon should be confined to an intensive study of 300 feet of gray sandstones, or of 500 feet of redwall limestones, instead of the 5,000 feet of all stones; but if there were guides with such minds, they lost their jobs before tourists went there.

But I am reminded of certain guides I did meet, who brought their cars of tourists to Hopi Point to watch the sun set into the heart of the Canyon one evening a few years ago. Down toward the cleft in the earth, becoming as red as the very sandstones of the mountains, the sun slowly dropped, far to the west, down toward the tops of the great peaks projecting from the sides of the Canyon, down into the piled labyrinths of plateaus and crags, down toward the spot where it must strike into the black of the inner gorge itself. From the jutting ledge, high up on the rim of the Canyon, we stood awe-stricken, half expectant of the crash of doomsday, when the fiery ball should split the very bowels of the earth. And then the guides became "schoolmarms," and they looked at their watches, and said it was time to return to the hotel for dinner, and they left me alone, to see the sunset. And the red heavens met red earth and joined with it, and great fires shot east and west and through every corner of the Canyon; every peak and projecting rock threw purple shadows, and the dusk of the evening poured into the gorge and filled up the Canyon, the night winds piled white mists into the black depths of the earth, and the moon, breaking through the clouds, trans-

formed the protrudent tops of the peaks into silver islands afloat on an ocean of white billows. Alone, I saw the sunset from Hopi Point, on that evening.

Often, as I have looked at biology curricula, I have thought of those guides at that Point, and their watches, and the tourists. I have seen biology syllabi that were brilliant introductions to organic structure, to hygiene, or to other aspects of the world, but I have seen them at the end of the semester pull their watches and say, "It is meet that you know so much and no more of the sunset, on this, which is your first evening." But I have known guides who have said: "No. In the few hours that are at our disposal we shall try to build a well-balanced, a complete story of the living plants and animals that are about us."

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,

The University of Oklahoma, Norman, Okla.

It is annoying to dwell upon such trifles; but there are times for trifling.—*Blaise Pascal* in *"Of the Geometrical Spirit."*

The attitude to change one's attitude is invaluable.—*Professor Kimball Young, "American Sociologist," in Scientific Monthly, March, 1924.*

The strongest of our scientific "instincts" is our ultimate belief in the simplicity of nature.—*Arthur Schuster in "The Progress of Physics during Thirty-Three Years."*

What we need is not the will to believe, but the wish to find out, which is the exact opposite.—*Bertrand Russell in "Skeptical Essays."*

The educationalist is the clearing-house between the psychologist and the teacher, just as the engineer is the clearing-house between the physicist and the artisan.—*Professor William D. Tait, psychologist, Scientific Monthly, August, 1929.*

The child must be taught endurance, and he can only gain that endurance by enduring. I am, therefore, very skeptical of the efforts to make scholarship too interesting, so that the child comes to believe that learning can be made easy. There is a peril in the merely interesting because it reflects itself in superficiality and lack of mental sturdiness. —*Abraham Myerson in "The Psychology of Mental Disorders."*

Is the fundamental assumption upon which professional "education" courses are based sound, to wit, that training in methods of teaching must precede or accompany training in the acquisition of content to be taught? If so, how is it that professors of "education" do not need to take courses in the manner of teaching courses in the methods of teaching?—*A question raised by the Tulane University Chapter of the American Association of University Professors in its proposal to investigate the value of professional courses in education, November, 1929, Bulletin of the A. A. U. P.*

TIME ALLOTMENTS IN PLANE GEOMETRY.

By Joseph A. Nyberg,

Hyde Park High School, Chicago.

The previous article, in the February issue, outlined the work for the first semester of Plane Geometry. This article outlines in the same way the work for the second semester. Each lesson represents forty minutes of time in class, and only the most important item of the day's work is stated. The chief object of the outline is to show how the time is apportioned among the various units in an average class.

This outline in 80 lessons may be useful to those who advocate covering both Plane and Solid Geometry in a year's time. Which of these units, for example, can be treated in fewer lessons? Which lesson can be omitted or abbreviated?

1. The construction of triangles. Discuss the notation used, and the fundamental cases wherein three parts are given. Give 15 minutes to the construction of a right triangle when the hypotenuse and an arm are given since this construction is much used.

2. Exercises in the construction of triangles given such parts as a, b, h_c, or a, h_c, C, or a, b, m_a.

3. The construction of triangles, parallelograms, trapezoids, etc.

4. Introduction to Loci. Review previous theorems which involve such loci as points equidistant from two given points or from two given lines.

5. An entire period is devoted to having the pupil work at his desk doing such exercises as:

Mark two points A and B. Construct three isosceles triangles all having AB for the base. If more such triangles are drawn, on what line would the vertices lie?

Mark two points A and B. Through A draw any three lines. To each of these lines construct a perpendicular from B. If more such lines were drawn through A and B, what would be true about the vertices of the right angles?

If the pupil actually does the constructing instead of merely talking about it he gets a good introduction to loci, but this method requires more time.

6. Fundamental Theorems about Loci. The proofs of later exercises about loci are much simplified if the pupil is allowed to state as his reasons not only the well known theorems about loci but also several others like:

The locus of points at a given distance d from a given line consists of two lines, one on each side of the given line, each parallel to the given line and at the given distance d from the given line.

The locus of points equidistant from two given parallel lines is the line parallel to and midway between the given lines.

7. Exercises on loci like: Find the points on a given line and at a given distance from a given point.

8. A 15 minute test on loci. Exercises, on the construction of circles, like: Construct a circle that shall have a given radius and pass through two given points.

9, 10. Review and further exercises on loci and constructions. Another 15 minute test on loci and constructions.

BOOK III. LESSONS 11 TO 47.

11. Introduction to Proportions. Time is saved by using the words numerator and denominator in place of antecedent and consequent. To emphasize that we are dealing with fractions I define a proportion thus:

Four numbers form a proportion, or are proportional, if the first divided by the second equals the third divided by the fourth.

12. Fundamental Theorems about Proportions. The first theorem states that the product of the means equals the product of the extremes; the second is a converse of the first. I state the other theorems in the form:

In a proportion (a) the extremes may be interchanged, (b) the means may be interchanged, (c) the fractions may be inverted, (d) the sum of the first two terms divided by the second equals the sum of the last two divided by the fourth.

13. One period is devoted to a review of algebraic work such as the solution of equations like

$$\frac{x-3}{10}=\frac{x+4}{15} \quad \text{and} \quad ax=bc$$

14. Further algebraic work, and the discussion of dividing lines proportionally. Also, at the beginning of each period hereafter I have a three or four minute oral review in which I ask such questions as:

What does it mean to say that four numbers are proportional?

What is the first theorem about proportions?

What kind of equations can be changed into proportions, and how?

What are the various ways of changing one proportion into another proportion?

15. Th. 1. A line parallel to one side of a triangle and intersecting the other sides divides the other sides proportionally. Corollaries.

The proof of the commensurable case is read and discussed. The pupil is not expected to reproduce it. It is sufficient if he learns how to use the theorem. A 15 minute test on the vocabulary and fundamental facts about proportions.

16. Find a fourth proportional to three given lines. The geometric work is preceded by some algebraic work in which the pupil writes and solves an equation for finding the fourth proportional to three numbers like 5, 7, 9.

17. Divide a given line into two parts proportional to two given lines. Again the geometric work is preceded by algebraic work in which, by means of an equation, the pupil solves a problem like: Divide 15 into two parts whose ratio will be 4 to 7. Such problems can also be solved without equations. In fact, this is a good place in which to correlate arithmetic, algebra, and geometry. But the arithmetic work should not be such that the pupil can guess the answer.

18. Th. 2. The bisector of an angle of a triangle divides the opposite side into parts that are proportional to the adjacent sides.

19. Th. 3. If the bisector of an exterior angle of a triangle intersects the opposite side, it divides the opposite side externally into parts proportional to the adjacent sides.

Give a 15 minute test on Lessons 16 to 19.

Theorems 2 and 3 and the constructions in Lessons 16 and 17 are good examples of how Th. 1 is used. Their introduction at this point, rather than later, focuses the attention on Th. 1.

20. Th. 4. If a line divides two sides of a triangle proportionally, it is parallel to the third side.

This theorem is used only in Th. 6; hence it is used chiefly to give the better pupils some practise with an indirect proof.

Half of this lesson is used to introduce the topic of similar polygons.

21. Th. 5. Two triangles are similar if the three angles of one are equal respectively to the three angles of the other.

This theorem deserves much attention because of its frequent use.

22. Proportions found from similar triangles. A full period is needed to discuss this topic and to present some examples of the use of Th. 5.

23. Applications of Th. 5. The pupil can do here as exercises Th. 11, 12, 13, and 14, thereby saving time later.

24. Further exercises on Th. 5. An important exercise is: Corresponding altitudes of similar triangles have the same ratio as any two corresponding sides. Note that I avoid the use of the expression "are to each other as."

25. Th. 6. Two triangles are similar if an angle of one equals an angle of the other and the including sides are proportional.

Th. 7. Two triangles are similar if their corresponding sides are proportional.

There are few exercises to which the pupil can apply Th. 7. Hence the time spent on it depends on the nature of the class. It could be omitted entirely, but it is interesting as it points out one difference between triangles and quadrilaterals.

In the three or four minute oral review at the beginning of each period I now ask such questions as:

What is the definition of similar polygons? Must both of these conditions be satisfied by triangles? Why not?

How are triangles proved similar?

What use do we make of the triangles after proving them similar?

26. Exercises which involve the plan: Two ratios can be proved equal by finding a third ratio equal to each of the given ratios. Also, a 15 minute test.

27. Th. 8. Two polygons are similar if they are composed of the same number of triangles similar each to each and similarly placed.

28. Th. 9. Two similar polygons can be divided into the same number of triangles similar each to each and similarly placed.

Theorems 8 and 9 and the construction of the figure for Th. 8 furnish a good review of the work on similar triangles.

29. As a preparation for Th. 10 prove: If two or more ratios are equal, the sum of the numerators divided by the sum of the denominators equals any one of the ratios.

Th. 10. The ratio of the perimeters of two similar polygons equals the ratio of any two corresponding sides.

30. Divide a given line into parts proportional to some given lines. Further review work.

31. Further review, or a 40 minute examination.

32. Before beginning the next unit it may be necessary to devote one lesson to a review of the theorems in Book Two about the measurement of angles. If the work in Lesson 23 showed that this is unnecessary, this day may be used for a discussion of any previous topic needing more treatment.

33. Th. 11. If two chords intersect inside a circle, the product of the segments of one chord equals the product of the segments of the other chord.

Th. 12. If from a point outside a circle two secants are drawn, the product of one secant and its external segment equals the product of the other secant and its external segment.

34. Th. 13. If from a point outside a circle a tangent and a secant are drawn, the tangent is the mean proportional between the secant and its external segment.

Exercises based on Th. 13.

35. Th. 14. The altitude to the hypotenuse of a right triangle is the mean proportional between the segments of the hypotenuse. Each arm of the right triangle is the mean proportional between the hypotenuse and the segment adjacent to that arm.

36. Construct a mean proportional between two given lines.
A 15 minute test on Lessons 33 to 35.

37. A lesson in arithmetic and algebra. As a preparation for the arithmetic work involved in the applications of the Pythagorean Theorem, review such ideas as

$$(\tfrac{1}{2}a)^2 = \tfrac{1}{4}a^2, \quad \sqrt{200} = 10\sqrt{2}, \quad \sqrt{\tfrac{1}{2}} = \tfrac{1}{2}\sqrt{2}$$

38. Th. 15. In a right triangle the square of the hypotenuse equals the sum of the squares of the arms. The converse.

39. Exercises based on Th. 15.

40. Numerical relations in an isosceles right triangle and in a 60-30 right triangle. Since many exercises use angles of 30°, 45°, and 60°, the relations between the sides are thoroughly discussed. An entire period is needed to do this.

41. Exercises with angles of 30°, 45°, and 60°.

42, 43. Reviews and tests on Lessons 32 to 41.

44, 45, 46, 47. The work for these lessons varies. Under one plan I spend four days on trigonometric work.

Under another plan I do mostly algebraic work. One day is spent on finding the altitude of a triangle when three sides are known by writing two equations in two unknowns and solving them. Other days may be spent in using (not proving) the theorems about the length of a median and of an angle bisector. Even if the proof of the theorems is entirely omitted the pupil can be taught to read and apply a statement like: The square of one side plus four times the square of the median to that side equals the sum of twice the squares of the other sides. Another day may be spent on non-geometric uses of proportions. The pupil who expects to study physics needs to learn how to write in algebraic language such statements as: The velocity is proportional to the time.

With a really slow group I do mostly review work. With a bright group I assign the theorems about angle bisectors and medians, and omit the trigonometric work since such a group will learn the trigonometry in a later course.

BOOK IV. LESSONS 48 to 66.

48. Introduction to Areas. Assume Th. 1: The area of a rectangle equals the product of its base and its altitude.

49. Th. 2. The area of a parallelogram equals the product of its base and its altitude. Exercises.

50. Th. 3. The area of a triangle equals one half the product of its base and its altitude. Exercises.

51. Exercises. The proof of the formula for the area of an equilateral triangle in terms of a side.

52. Exercises using (not proving) the formula for the area of a triangle in terms of its sides. This work reviews the study of square roots and the simplification of radicals.

53. Th. 4. The area of a trapezoid equals one half the product of its altitude and the sum of its bases. Exercises.

54. Exercises. A 15 minute test on areas.

55. Th. 5. The ratio of the areas of two similar triangles equals the ratio of the squares of any two corresponding sides.

56. Th. 6. The ratio of the areas of two similar polygons equals the ratio of the squares of any two corresponding sides.

57. To appreciate Th. 5 and 6 many numerical exercises are worked. I find it useful to state Th. 6 as: If the sides of one polygon are k times the corresponding sides of a similar polygon, the area of the first polygon is k^2 times the area of the second; and conversely.

58. Construction of squares and equilateral triangles two or three times as large as others by using Th. 6 and Lesson 40.

59. Review of areas. A 20 minute test.

60. The use of the Pythagorean Theorem to construct a square equal to the sum or the difference of two given squares.

Prove the theorem: If similar polygons are drawn on the sides of a right triangle as corresponding sides, the polygon on the hypotenuse equals the sum of the other polygons.

61. Construct a square equal to a given parallelogram. The use of algebraic analysis to solve similar construction problems.

62. Exercises in which algebraic analysis is used. This work is useful because it correlates algebra and geometry.

63, 64, 65, 66. Review of Book Four. On two of the four days tests of 20 minutes each are given.

BOOK V. LESSONS 67 TO 80.

67, 68. Regular Polygons. Th. 1. A circle can be circumscribed about any regular polygon. A circle can be inscribed about any regular polygon.

69. Th. 2. If a circle is divided into any number of equal parts, the chords joining the successive points of division form a regular inscribed polygon, and the tangents at the points of division form a regular circumscribed polygon.

70. Inscribed and circumscribed squares. Numerical exercises. Algebraic exercises like: If the radius of a square is R, the side equals $R\sqrt{2}$, the area equals $2R^2$, and the apothem equals $\frac{1}{2}R\sqrt{2}$. The pupil cannot be expected to do such work unless Lessons 37, 40 and 52 are introduced in the course. I assume that the pupil remembers very little of his ninth grade work and discuss each algebraic step very carefully.

71. Inscribed and circumscribed regular hexagons and triangles. Numerical exercises. Algebraic exercises like: If the radius of an equilateral triangle is R, the side equals $R\sqrt{3}$, the apothem equals $\frac{1}{2}R$, and the area equals $\frac{1}{4}R^2\sqrt{3}$.

72. Th. 3. Regular polygons of the same number of sides are similar. Th. 4. The area of a regular polygon equals one half the product of its perimeter and its apothem.

73. A 20 minute test on Lessons 70 and 71. Begin the mensuration of circles. I make no attempt at proving the theorems about the area and the circumferance, but assume the two usual formulas and use them in exercises.

74, 75. Exercises about circles. By assuming that $C=2\pi r$ and $A=\pi r^2$ it is easy to find the ratio of the circumferences and the ratio of the areas. I spend the time in applying these facts to exercises rather than in introducing the topic of limits.

76, 77, 78. Extreme and Mean Ratio. The construction of an angle of 36°. This work is not required by the College Entrance Examination Board and is not included in the recommendations of the National Committee. With a group of the very slowest pupils I omit it and devote the time to review. With most groups I find time to include this interesting work. To me it seems more worth while than discussing how pi is computed or any work on limits.

79, 80. Review work.

The amount of time spent on the various units is then:

	Lessons	Number of Lessons
Constructions	1-3, 8-10	5
Loci	4-10	5
Proportions	11-13	3
Lines Divided Proportionally	14-20	7
Similar Polygons	21-30	10
Review	31, 32	2

Relations based on Similar Triangles	33-36	4
Pythagorean Theorem and Applications	37-41	5
Review	42, 43	2
Trigonometric Ratios, or Other Numerical Relations, or Review	44-47	4
Areas	48-54	7
Areas of Similar Polygons	55-62	8
Review of Book Four	63-66	4
Regular Polygons	67-72	6
Circles	73-78	6
Review	79, 80	2

DISCUSSION BY MISS MARTHA HILDEBRANDT, PROVISO TOWNSHIP HIGH SCHOOL, MAYWOOD, ILL.

My assignments for the second semester seem to contain more material than Mr. Nyberg's outline indicates. Perhaps that is why I change it every time I teach the work and invariably end with a wish for more time because there are so many interesting things to which my class has not been exposed.

From the time we begin work on proportions until the end of the semester we use almost daily a supply of verbal problems applying geometrical principles and requiring algebraic solution —more than Mr. Nyberg shows in his outline. This computation includes work in equations in one and two unknowns, proportions, radicals, and even factoring as it gets to be a game with the student to arrive at his results with the least amount of arithmetical labor. This daily supply makes the special lessons in algebra unnecessary.

We do lessons 70 and 71 more elaborately, using both the inscribed and circumscribed triangle, square, and hexagon, and make a tabulation of our findings which includes the ratios of the sides, perimeters, and areas of the inscribed and circumscribed polygons of the same number of sides. These formulas are then used in the solution of exercises, and hence emphasize the theorems on the relationship of perimeters and areas of similar figures as well as emphasizing the value of the formula.

In the construction exercises we include much of lessons 1 to 3 after the study of loci, and at that time give fourteen lessons on loci and constructions. We find that the work on loci enables the student not only to analyze his problem and make the construction but to discuss all possible cases. I notice that the construction of the mean proportional to two line segments is briefly listed. My pupils usually find many methods of making this construction as well as that of the fourth proportional to three given line segments. A very interesting discussion concerning the relative merits of each construction arises.

To answer the question asked at the beginning of the article, I can say that I have never had time to include any work on Solid Geometry.

BACKGROUND AND FOREGROUND OF GENERAL SCIENCE.

NO. X. THE ECLIPSES OF APRIL 12 AND 28.

By WM. T. SKILLING,

State Teachers' College, San Diego, Calif.

Interest being so essential a feature of successful teaching, especially of young students, the general science class should take advantage of current happenings. "Strike while the iron is hot" is as necessary a procedure with teachers as with blacksmiths. Regardless of what the prescribed order of topics for the course may be one is excusable for teaching meteorology after a tornado, flowers in May, and animal life when the circus happens to be in town.

This year since pupils throughout the United States and Canada will be interested in witnessing at least a partial eclipse of the sun of April twenty-eighth, then will be the natural time to explain the cause and nature of eclipses.

This particular event will present all of the variations possible in a solar eclipse. In some places it will be total, in others annular, and in most places of the ordinary partial variety. The favored locality where the entire sun is obscured is a very narrow strip crossing California near San Francisco. In the extension of this same narrow strip across the Rocky mountains into Montana and Canada the inhabitants will see all of the sun blotted out except a very narrow ring around the edge, that is, the eclipse will be annular. In all other parts of the country a great circular bite, more or less deep depending on the location of the observer will be taken out of one side of the sun.

To the astronomer the only eclipse of interest is one that is total or very nearly so. To see the pearly white glow called the corona the whole body of the sun must be covered by the moon. This upper atmosphere which extends out as far above the surface sometimes as the sun is wide is too faint to be seen unless the glare of the sun itself is gone.

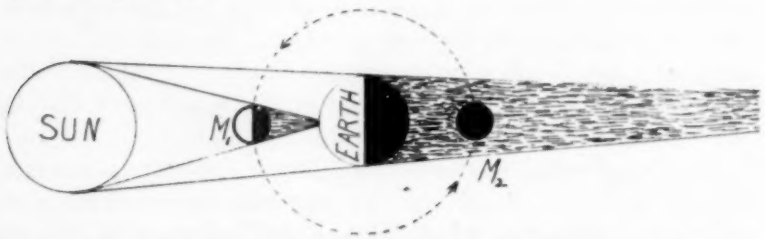
The lower part of the atmosphere, called chromosphere, can be studied with the aid of the spectroscope if 98 per cent or more of the sun's surface is covered. The chromo-

sphere, moreover, is the most interesting part of the sun in some respects. It is there that the elements of which the sun is composed can be detected with the spectroscope. Especially in the lower part of the chromosphere, called the reversing layer, are the most of the elements seen. They do not rise into the upper atmosphere, and if they sink into the body of the sun itself they do not register their lines in the spectrum.

This eclipse offers a specially good opportunity to photograph the spectrum of the atmosphere down almost to the surface of the sun, for the moon this time barely covers the sun and leaves its encircling atmosphere exposed. The reason for this is that the moon, which varies in its distance from the earth from about 222,000 miles to 253,000 miles is now quite far away.

A penny held close enough to the eye will cover a mountain. Held farther away it will not. So it is with the moon. The reason this eclipse is annular throughout most of the length of the central strip is that the moon is too far away to cover the whole sun. Its angular width is at the time a little less than that of the sun as seen from where the eclipse takes place.

Instead of thinking of a solar eclipse as being caused by the moon interposing itself between us and the sun so as to cut off our view we may with equal propriety conceive of the cause as being the shadow of the moon which falls upon the earth. People living in this shadow cannot see the sun. (See diagram.)



THE CAUSE OF SOLAR AND LUNAR ECLIPSES. M_1 THE NEW MOON ECLIPSING THE SUN. M_2 THE FULL MOON ECLIPSED BY THE EARTH'S SHADOW.

Like the shadow of the little boy of whom Robert Louis Stevenson tells, the moon's shadow always goes along with it. The moon being round and so much smaller than the

sun its shadow is conical. A long, dark, slender, pointed shadow stretches out like a feeler, reaching about 230,000 miles into space. Only when this feeler touches the earth is there an eclipse.

It would seem as if there should be an eclipse every time the moon is new; that is, when it passes between us and the sun. But it usually does not pass *exactly* between sun and earth. Oftener the shadow of the moon like a long pointed pencil reaching out nearly toward us misses the earth, passing many miles to one side. Seldom does it trace its black mark right across the earth's face, giving an eclipse. Due to the five degree inclination of the moon's orbit with respect to the plane of the earth's orbit the point of the shadow cone may pass as much as 16,000 miles north of the north pole or south of the south pole.

The eclipse in this instance begins far out in the Pacific Ocean. The shadow travels eastward at the rate of about twenty-five miles a minute on account of the moon's motion just as the shadow of a bird or of an airplane sweeps along the ground. When it reaches the coast near San Francisco at about 11 o'clock it is only a spot less than half a mile across. As it flies forward over the mountains only those within this half mile strip will see the sun totally eclipsed. Those to either side will have but a partial eclipse.

Several observatories are planning to set up observing stations at various points along the favored area. The spot moves forward so rapidly that in no one place is the duration of the total eclipse quite a second and a half. In this short time the pictures must be snapped. Observers without instruments may enjoy for a trifle more than a second the beautiful sight of the sun's pearly white "corona"-crown.

Beyond California the size of the eclipse spot narrows down gradually to nothing by the time it reaches Montana. This is where the point of the shadow cone just touches ground. Farther on, because the earth's surface curves farther away, the shadow point hangs in air overhead, and those directly under it will see the outer edge of the sun as a ring, an annular eclipse.

Eclipses nearly always come in pairs, a solar and a lunar eclipse with an interval of two weeks between. As already mentioned the moon must pass almost exactly between the

earth and the sun at new moon in order to hide the sun. Usually it is thousands of miles to one side or the other of the line joining the two.

For a lunar eclipse the moon must be in almost a straight line behind the earth from the sun. When the three bodies are nearly enough in the same straight line to cause a solar eclipse at new moon, they are almost certain to be nearly enough in line at the next full moon to bring about an eclipse of the moon.

At the eclipses in April of this year that of the moon comes first. It occurs on the twelfth at about midnight by central standard time. It is followed half a month later by the solar eclipse on the twenty-eighth. By the time the moon is full again the alignment of sun, moon and earth is not sufficiently perfect for the earth's shadow to fall on the moon as it passes behind the earth. Unless the moon passes through the earth's shadow it is not eclipsed.

The earth's conical shadow is more than a hundred times as long as the earth is wide. Eight thousand miles wide where it leaves the earth the shadow is still about 5,700 miles in thickness at the point where the moon passes through it. That is, if the moon, which is 2,160 miles in diameter, has to pass through the center of the cone shaped shadow it remains totally eclipsed while it travels nearly twice its own width. Thus, at the rate at which the moon moves it may remain totally eclipsed for about two hours.

At this eclipse, however, the moon cuts through only the edge of the shadow and its whole face is at no time entirely immersed in blackness. The eclipse is partial.

The shape of the shadow on the moon being circular shows that the earth, which casts the shadow, must be round.

When the moon is entirely within the earth's shadow, and therefore totally eclipsed, it is still visible, glowing faintly with a dull orange color. The reason for this is that the shadow is not wholly dark. Some light bends into it as the sun's rays grazing the earth pass through the atmosphere.

The peculiar color is accounted for by the fact that blue light is unable to penetrate so great a thickness of atmosphere as readily as do the colors of greater wave length, such as orange and red.

Though eclipses of the sun occur somewhat more frequently than do those of the moon, lunar eclipses are much more frequently seen by any one individual. A total eclipse of the sun cannot be seen outside of a strip across the country which never exceeds about 130 miles in width, and is usually much narrower, as in this case. Every eclipse of the moon can be seen by all the people on the night side of the earth. Due to the rotation of the earth during the two or three hours that the eclipse may last more than half the world may see it.

How it is possible to predict that at a given moment in April the shadow of the moon will cover a given plot of ground half a mile in diameter is something of a scientific marvel. The astronomer must know just about what one would have to know about the flight of an airplane to predict when and where its shadow on the ground would be found. It would be necessary to know the exact time and course of the plane's flight, and also the position of the sun in the sky at the time. The astronomer must have this set of data about the moon and sun.

As far back in ancient times as there is any record of the Chaldeans and Babylonians these keen observers of the heavens had noticed that eclipses repeat themselves after an interval of 18 years 10⅓ days. This made a method which they employed of predicting eclipses.

Eighteen years 10⅓ days hence there will be an eclipse of the sun very much like the present one. It will therefore occur May 8, 1948. It will be in about the same latitude as the present one and the width, length and direction of its track will be similar. But on account of the extra third of a day required for it to come the earth will have time to make an extra third of a revolution making the eclipse one-third of the way around the world west of where it occurs this year. That will place it in Asia.

UNITED STATES BOUNDARY LINE CHANGED.

How would you like to make a tour along the entire boundary line of the United States? Few of us have ever thought of such a journey. Suppose we limit the trip to one small part of the United States—the Philippine Islands. From north to south we should have to travel about as far as from Duluth to New Orleans and our trip around would encircle more than 7,000 islands. A recent agreement between England and the United States fixed the boundary between North Borneo and the Philippines and thereby attached seven homeless islands to Uncle Sam's household without firing a shot.

UTILIZING THE NATURAL INTERESTS OF PUPILS IN TEACHING BIOLOGY, PART IV.

By O. D. Frank,

School of Education, The University of Chicago.

The Balanced Aquarium

No nature-study room is complete without an aquarium. All normal boys and girls are interested in living things. Living, moving animals have an impelling continued interest and appeal not only to children but to grown-ups as well.

The aquarium need not be pretentious. A mason jar, a pan or bucket, or even a glass tumbler will answer the purpose.

Experience will teach what can be successfully kept in the aquarium. Fish, frogs, toads, tadpoles, toad tads, mud puppies, turtles, insects and insect larvae as well as many kinds of plants may be kept in aquaria in most any schoolroom and they always pay large dividends in interest and enthusiasm.

The "Cricket Garage"

Crickets are such cheerful folks and they are so easily kept that every nature study room should have a supply of these captivating creatures.

Fill a four or five inch flower pot almost full of rich soil. Fasten a piece of cheese cloth over the top of a lamp chimney and set it in the flower pot, and lo and behold you have a "cricket garage." Thin wedges of apple is all the food that is required. Watch the little fellows eat their "sandwiches" edgewise and listen to their cheery songs after their "tummies" have been filled. You have often wondered how crickets chirp. Stop, look, listen, and learn first hand. The understanding smile of satisfaction and joy that comes into the eyes and spreads over the faces of boys and girls when they see a cricket eat and see and hear him chirp is beautiful to behold.

Taraxacum Officinale

What is a name? Taraxacum, which means to disquiet or disorder, in allusion to medicinal properties, is the scientific name of the common Dandelion. Boys and girls find delight in learning big names to "show off" their knowledge to the uninitiated. At the dinner table John mentions in a

casual, matter-of-fact tone that something ought to be done about the Taraxacum officinale growing in the yard. Out of the corner of his eye John drinks in with satisfaction dad and mother's amazement and sister Sue's disgust at his display of knowledge.

Because the Dandelion is so successful in solving the many problems that every living thing must solve in order to live, grow, and reproduce its kind, it is a most interesting plant for study.

Conduct the nature-study class to a nearby vacant lot and observe this successful, thrifty little golden-headed member of the composite family vying with the other plants growing there. Even casual observation will reveal that the Dandelion is the "English Sparrow" of the plant kingdom. Note the rosette of long, narrow, deeply notched leaves (the notches resemble a lion's tooth hence the name Dandelion) that lies flat on the ground thus shading the surrounding territory. This prevents other less hardy plants from growing near and the shading of the ground conserves the moisture. The plant being near the surface of the soil has the warmest place in cool weather and the coldest place in warm weather for growing. This habit prevents grazing animals from biting it off easily and helps the plant to escape the lawn mower to our disgust. The bitter taste of the plant also prevents most animals from eating it. The long, sturdy tap root grows deep into the soil thus securing firm anchorage for the plant. The Dandelion has a most curious and interesting habit in connection with the tap root. As the stem of the plant elongates by growth, the tap root shortens by wrinkling and in this way keeps the rosette of leaves constantly pressed close to the surface of the ground.

The Dandelion is no less successful in its seed production and seed dissemination than it is in solving its other problems. The attractive yellow blossoms, each of which is really a city of flowers all in one head, offer a reward of nectar and pollen to insect visitors. Note the shortness of the blossom stem and the bitter "milk" that oozes out when the flower is plucked. Observe the closed blossom late in the evening or in the early morning and in cold or rainy weather. Examine the long hollow stem with the old man's

head or blowball at the top. Each seed is a perfect little parachute that caters to the wind. Wise little Dandy "knows" that the wind has no eyes or "sweet tooth" and that to use the wind for scattering its seeds, it must get its head high in the air. Note the little hooks on each seed that enables it to anchor its pointed self and thus get itself planted in Mother Earth at a distance from the Mother Plant.

A study of this versatile plant compels our admiration. Indeed, we can learn many lessons from this thrifty, beautiful, despised little Trojan that defies us in our own front yards.

Growing Dandelions

Living things, either plants or animals, give added interest to the nature-study room. Lack of sufficient sunlight, irregular temperatures of the room during week ends and the prevailing dryness of the air make it impossible to grow plants such as geraniums, begonias, ferns, and other house plants in the average school room.

Dandelions, the most successful of all plants, burdock, cactus and other wild hardy plants may be grown successfully in spite of the conditions mentioned above. Simply dig them up late in the fall, place them in generous pots filled with good dirt, keep them watered—very little for the cactus—and you will have an interesting wild flower "garden" throughout the year.

Baked Potato for Bacteria Culture.

As the title suggests, a baked potato furnishes an ideal sterile media for growing bacteria cultures. Bake the potato, let it cool, open and inoculate it and place it in a sterilized mason jar. (Place the jar, rubber, and lid in boiling water for fifteen minutes before placing the potato in it.)

Electric Chart

Electric charts with guide cards can be purchased in the toy department of most large stores for about three dollars. They furnish a splendid means of instruction and amusement for the children of the lower grades. Boys who are interested in electrical devices can build an electric chart once they have seen one operate.

VICTROLA DAY

Some schools and many homes have portable victrolas and numerous records. Appoint a committee whose privilege it will be to get together records, pertaining to nature study such as bird songs, sounds of the forest, the "Tar Baby," etc., and let them put on an "ear" program for Friday afternoon.

This is something different and will create a good deal of interest. Some one has said that something different is better even if it isn't as good.

LIFE CYCLES

No living thing lives unto itself. All living things depend upon other living things for food. Even the plants obtain food materials from fertilized soil. Robins catch worms; Jays eat the eggs and young of robins; Hawks catch Jays and man kills the Hawks.

Fish eat worms and insects; Frogs swallow fish; Birds capture frogs and they, in turn, are eaten by other birds and by mammals. Working out these "catch as catch cans" is a most fascinating study. Another title for the game might be "Who wants the worm?" or "Life is just one thing after another."

NATURAL SCIENCE READING RECORDS

Keeping a record of the voluntary supplementary reading of books and magazine articles pertaining to nature study is an excellent method for interesting boys and girls in plant and animal life.

The following is a suggestive outline for keeping the record: Author. Title of book or article. Publisher. Number of pages read. A brief statement of your impression of the book or article read.

THE HIGH SCHOOL SCIENCE LIBRARY.

Recently several requests have come to this office for lists of books suitable for high school science reference and supplementary reading. In answer we refer to our monthly list of new books described under the heading "Books Received." Many of these are reviewed in later issues. Professor H. A. Webb, George Peabody College for Teachers, Nashville, Tennessee, informs us that he is able to furnish the following lists:

The High School Science Library 1910-1924	25c
Supplement 1925-26	10c
Supplement 1926-27	10c
Supplement 1927-28	10c
Supplement 1928-29	10c

DOES THE ETHER DRIFT?

A Summary of the Ether-Drift Experiments.

By D. H. Palmer,

Long Beach Junior College, Long Beach, Calif.

The experiment conducted in 1887 by Michelson and Morley seemed to have settled for all time the question of the relative motion of the earth through a ponderable ether. The apparatus used at that time was an exceedingly ingenious arrangement (interferometer principle first used) and the experiment was conducted with sufficient accuracy to detect a measurable "drift." Additional support was given to these results when Einstein introduced the theory of relativity which not only does not assume the existence of an "ether" but throws out the idea entirely.

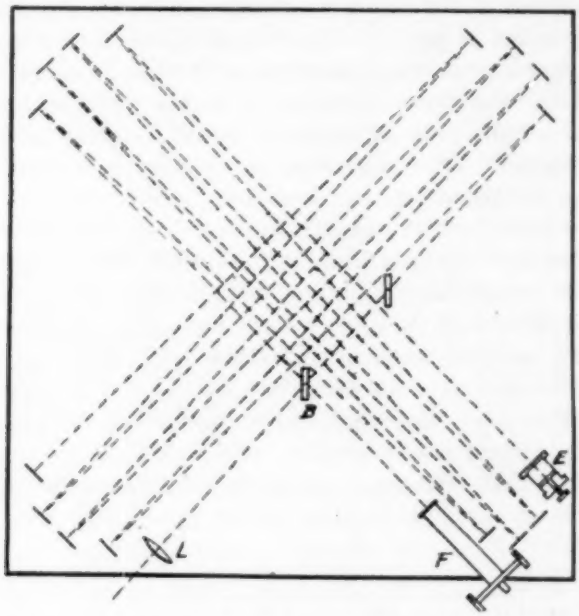
Recently, however, the question was again opened due to the experiment carried on by D. C. Miller at the Mount Wilson Observatory, in California. Still more recently experiments giving quite different results from those of Miller have been performed and have received widely different interpretations.

A summary of the original experiment by Michelson and Morley will be given here with a survey of the recent attempts to prove or disprove the conclusions first drawn.

If we make two measurements of the velocity of light, one in the direction in which the earth travels and the other at right angles to this, then the time it takes light to travel over the same length of path is greater in the first case than in the second, *providing the earth moves relative to the medium in which the light is propagated.*

The apparatus for detecting any such relative motion is shown in the accompanying diagram. The apparatus "was mounted on a stone support, about four feet square and one foot thick, and this stone was mounted on a circular disc of wood which floated in a tank of mercury. The resistance to motion is then exceedingly small, so that by a very slight pressure on the circumference the whole could be kept in slow and continuous rotation. It would take, perhaps, five minutes to make one single turn. With this slight motion there is practically no oscillation; the observer has to follow around and at intervals to observe whether there is any displacement of the fringes." [1] The diagram is almost self-explanatory. The lens (L) makes the rays nearly parallel. The dividing surface (B) and the two paths at right angles to each other are easily recognized. After the light re-

unites at (B) it enters the telescope (F) where the interference bands or fringes may be seen. The telescope is furnished with a micrometer screw to determine the amount of displacement of the fringes, if such displacement occurs. The last mirror (E) is mounted on a slide so that the two paths may be made equal to the necessary degree of accuracy—something of the order of one fifty-thousandth of an inch.



It can be shown that the difference in time it takes the light to traverse the two paths may be expressed as

$$t_1 - t_2 = \frac{lu^2}{c^3} \qquad \text{(first approximation)}$$

Where l is the length of path, u is the velocity of the earth relative to the ether and c is the velocity of light. The total displacement of the fringes due to the rotation of the apparatus is given as

$$\alpha = 2\,\frac{lu^2}{\lambda c^2} \quad \text{where } \lambda \text{ is the wave length of light.}$$

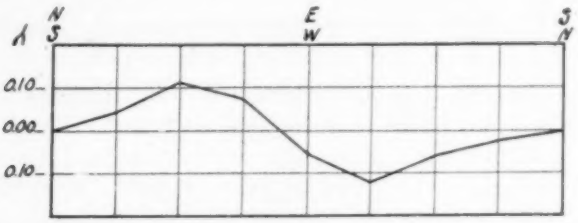
The translatory velocity of the earth is only the ten-thousandth part of the velocity of light, so that $\frac{u^2}{c^2}$ is equal to 10^{-8}. The length l in the Michelson and Morley apparatus was 11m., and since λ is about $6\text{x}10^{-5}$ cm, α is equal to 0.4. The rotation of the

apparatus should have caused a displacement of the interference fringes through about half the distance between two neighboring fringes. No such displacement was observed.

It is interesting to note Michelson's conclusion, "Since the result of the experiment was negative, this problem (velocity of the earth relative to the ether) is still demanding solution."

In 1905 and 1906 Morley and Miller repeated the experiment at an altitude of 300 feet above Lake Erie in an attempt to get away, as much as possible, from the dragging effect of the ether. A new instrument was constructed for this experiment which was about four times as sensitive as the previous one used, "having a light path of 224 feet, equal to about 150,000,000 wave-lengths." The difference in velocity was found to be less than 3.5 kilometers per second.[3]

Miller continued the experiments at Mount Wilson Observatory and at Cleveland from 1921 to 1925. Some 5,000 single measures were made at various times of day and night and at different epochs of the year. The apparatus was substantially the same as that used in 1904-1906 by Miller and Morley. All possible factors, such as variation in heat, light sources, and air currents were carefully studied, but all of the experiments gave the same positive results. An actual observation, taken in 1924 at Mt. Wilson, is given in the accompanying graph. Other observations were quite similar.



Miller sums up his work as follows: "The ether-drift experiments at Mount Wilson during the last four years, 1921-1925, lead to the conclusion that there is a relative motion of the earth and the ether at this observatory, of approximately nine kilometers per second, being about one-third of the orbital velocity of the earth. By comparison with the earlier Cleveland observations, this suggests a partial drag of the ether by the earth, which decreases with altitude. It is believed that a reconsideration of the Cleveland observations, from this point of view, will show that they are in accordance with this pre-

sumption and will lead to the conclusion that the Michelson-Morley Experiment does not give a true zero result."[3] Some time later he states: "The complete study of the results leads to the conclusion that there is a systematic displacement of the interference fringes corresponding to a constant relative motion of the earth and the ether at the observatory of 10 kilometers per second, and that the variations in the directions and magnitude of the indicated motion are such as would be produced by a constant motion of the solar system in space with a velocity of 200 kilometers per second towards an apex in the constellation Draco, having R. A. 262° and declination +65°. In order to account for these effects it is necessary to assume that the earth drags the ether so that the apparent relative motion at the point of observation is reduced to 10 kilometers per second, and that this drag also displaces the apparent azimuth of the motion about 45° to W. of N."[4]

With the publication of Miller's results many new experiments were carried on which seemed to disprove his results. Hans Thirring of the University of Wien states: "It appears that on account of the extreme difficulties of the measurements, which were vividly described by Prof. Miller, . . . the results of the Michelson experiments are less trustworthy and less stringent than they have been supposed to be. The Trouton-Noble experiment offers considerably less difficulty, and its negative results may be regarded as more convincing. Dr. R. Tomaschek, of the University of Heidelberg, has repeated this experiment at an altitude of 11,400 feet at the Jungfraujoch, Switzerland.[5] The observed effects did not exceed the errors of observation; and it was concluded that there is no relative velocity of the ether greater than three kilometers per second at the given altitude . . . . My conclusion is, therefore, that the effect (observed by Miller) must not be attributed to any cosmic cause at all, but may be due to local disturbances."[6]

The Trouton-Noble Ether Drift experiment depended upon the fact that if a parallel-plate condenser, moving with respect to a stationary ether, is charged, it can be shown that under certain conditions there will exist a couple tending to rotate the condenser. If the condenser is suspended by means of a delicate fiber in such a manner that the plates are in a vertical plane, the couple will be given by the expression $K = \frac{1}{2}CV^2\beta^2\sin 2\psi \sin^2 z$ where C is the capacity of the condenser; V, the potential to which it is charged; B, the ratio of the velocity of the moving

condenser to the velocity of light; ψ the angle between the direction of motion and the suspending fiber (the zenith distance). The couple is a maximum when $\psi = 45$ and $z = 90°$.[7] Trouton and Noble obtained negative results in 1902. More recently C. T. Chase repeated the experiment, after some improvement of the apparatus which made it possible to detect a motion relative to the ether of 4 kilometers per second, but no such motion was found. Chase again repeated the experiment,[8] using Epstein's correction which changed the expression for the couple to $K = (CV^2v^2/10\epsilon c^2)\sin 2\psi \sin^2 z$, where ϵ is the dialectric constant; v, the velocity of the condenser with respect to the ether; and c, the velocity of light. The apparatus used should have detected a motion in the ether as low as 3 kilometers per second, but no motion was found.[8]

The Michelson-Morley apparatus was again set up by K. K. Illingworth, using a modification suggested by Kennedy. This consisted of a small step, one-twentieth of a wave-length thick, in one of the total-reflecting mirrors of the interferometer. "Because of the small difference in path to the two halves of the step mirror a slight discontinuity exists between the fringe systems on either side of the step, the two systems being out of phase by one-tenth of a fringe. In general this produces a sharp change in intensity . . . . This equality of the two halves of the field constituted a very delicate test as to the exact position of the fringes . . . ."[9] It was found that in over one half the cases the observed shift was less than the probable error, which showed that any ether drift must be less than one kilometer per second or one-tenth of the velocity found by Miller.

A. Piccard and E. Stahel repeated the Michelson experiment at Brussels by placing the apparatus in a free balloon. Testing at altitudes of 2500 and 4500 meters showed no change in ether drift with altitude.[10] Experiments carried on in their laboratories in Brussels gave no indication of an ether drift,[11] and the same negative results were obtained with a Michelson interferometer at the Rigi.[12]

All of the latest experiments seem to disprove Miller's results and point to the correctness of the conclusions drawn from Michelson's and Morley's first measurements by Einstein and others. Haas states, "It was due to the critical ingenuity of Einstein that the contradiction (negative results of the Michelson-Morley experiment) was first solved from a much more

general point of view. Einstein accomplished this by liberating physics from a deeply rooted prejudice which, owing principally to Newton's influence, had become a fundamental concept of theoretical physics; this was the concept of absolute time."(2)

We seem, then, to be back where Michelson and Morley left us. There is still insufficient proof for ether-drift and probably no such hypothetical medium as ether exists.

Note: *Science*, for Nov. 1, 1929, carries the statement in the Science News section that Professor Miller has recently obtained additional evidence for an "ether drift." Quoting directly, "Again he finds an observed effect in the light path of his apparatus such as would be produced by a relative motion of the earth and the ether of about ten kilometers (six miles) per second."

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(1)A. A. Michelson—Light Waves and Their Uses. The University of Chicago Press, 1902.
(2)Haas, Arthur—Introduction to Theoretical Physics, Vol. II. D. Van Nostrand Co., 1926.
(3)Dayton C. Miller—Ether-Drift Experiments at Mount Wilson Nat. Acad. Sci. Proc. 11 pp., 306-314.
(4)D. C. Miller, Significance of the Ether-Drift Experiments of 1925 at Mount Wilson, Science 63 pp. 433-443.
(5)Ann. d. Phys. Vol. 76, p. 743, 1926.
(6)H. Thirring, Miller's Ether-Drift Experiments. Nature, 118 pp. 81-82, 1926.
(7)C. T. Chase, A Repetition of the Trouton-Noble Ether-Drift Experiment. Phys. Rev. 28, pp. 378-383, 1926.
(8)C. T. Chase, The Trouton-Noble Ether-Drift Experiment. Phys. Rev. 30, pp. 516-519.
(9)K. K. Illingworth, Repetition of the Michelson-Morley Experiment. Using Kennedy's Refinement. Phys. Rev. 30, pp. 692-696, 1927.
(10)Comptes Rendus 183, pp. 420-421.
(11)Comptes Rendus 184, pp. 152, 1927.
(12)Comptes Rendus 185, pp. 1198 and 1200, 1927.

NEW REPORT ON INDIANA OOLITIC LIMESTONE.

As the Indiana oolitic limestone constitutes more than three-quarters of the limestone used for building stone and nearly one-half of the total building stone of all kinds produced in the United States, and as it enters into buildings of nearly all classes, a report recently issued by the Department of the Interior, entitled "Indiana oolitic limestone; relation of its natural features to its commercial grading," should be of much interest to architects, construction engineers, building contractors, and others connected with the building industry. This report, which was written by G. F. Laughlin, of the Geological Survey, and may be obtained from the Superintendent of Documents, Washington, D. C., for 30 cents, was prepared in cooperation with the Supervising Architect's Office, the Bureau of Standards, and the former Indiana Limestone Quarrymen's Association.

As the distinctive features and usefulness of Indiana limestone depend upon its origin and natural occurrence, the report begins with a much simplified and well-illustrated account of its formation and then discusses such practical questions as resistance to weathering and the significance of physical properties. The comparative properties of different grades of the stone are shown on charts based on a large number of tests made at the Bureau of Standards. Criteria for grading are considered, and specifications for each grade are recommended.

THE DOOR PROBLEM.

By Roy R. Hatch,
Mount Hermon School, Mount Hermon, Mass.

Door Problem, Illustrating Parallel Forces, Couples, and Forces Acting at Right Angles, Parallelogram of Forces.

The apparatus consists of a planed board one foot wide and two feet long, to represent the door.

Support this board in the manner shown in the diagram by means of pulleys and weights.

The weight of the door may be made to represent any amount by adding weights at W.

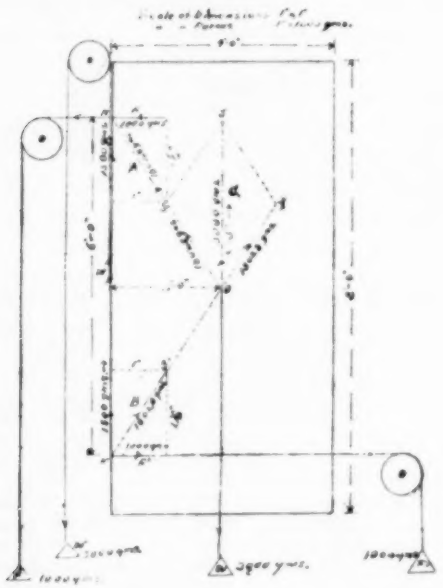
The upward push of the hinges is represented by the weight W″ and the horizontal push of each hinge is represented by the weights F and F″ respectively.

Solution by Couples:

The horizontal forces, F and F″ on their respective hinges represent the Horizontal Couple and the vertical forces, W and W″ represent the Vertical Couple.

The Moment of the Horizontal and Vertical Couples are equal, i.e.

$$6 \times 1000 = 2 \times 3000.$$



Solution by Parallelogram of Forces:

Lay off parallelograms A and B about hinge H and H″ as shown, the horizontal and vertical dimensions representing the respective forces acting on the hinges. Extend the diagonals of these parallelograms HG and H″G″ respectively through O the center of gravity of the door. Construct the parallelogram C as shown the sides of which are equal to the diagonals of the parallelograms A and B. Draw the diagonal JO of parallelogram C and this diagonal to the scale used will represent the weight of the door.

AN EXPERIMENT TO DETERMINE—a. THE LOCAL GEOGRAPHIC MERIDIAN, b. THE LOCAL DECLINATION OF THE MAGNETIC COMPASS, c. THE TIME OF APPARENT SUN NOON, d. THE LONGITUDE OF THE OBSERVER, AND e. THE LATITUDE.

By Frederic H. Holmes,

Mathematics Department, Redford High School, Detroit, Mich.

The imaginary plane "determined" by the axis of the Earth and the point at which the experiment is performed intersects the surface of the Earth in the local Geographic Meridian.

Extended indefinitely, this same plane intersects the dome of the sky in the local Celestial Meridian. Apparent Sun Noon is the precise instant of time at which the center of the disc of the Sun is on the Celestial Meridian, and it is at that moment that observation will give the data with which the observer may calculate his Longitude and Latitude.

Clearly, the "determination" of this local meridian plane is the first objective of the experiment.

The essential parts of the apparatus are—*a pin-hole, rigidly supported above a horizontal plane surface.* (Fig. 3).

The apparatus is so placed that, as the Sun crosses the mid-day sky from east to west, its pin-hole image crosses the horizontal plane surface from west to east. At regularly timed intervals, the outline of the image is traced, and the time recorded. (Fig. 1.)

The vertical line through the pin-hole, p, intersecting the horizontal plane surface, at o, and extending upward to meet the Celestial Meridian at the observer's zenith, z, must lie wholly in the meridian plane. (Fig. 1.)

The ray of light extending from the center of the Sun's disc at culmination—M—(Apparent Sun Noon) through the pin-hole, p, to c, the center of the corresponding image on the horizontal plane surface must also lie wholly in the meridian plane. (Fig. 1.)

These two intersecting lines must "determine" the local meridian plane. Therefore the pin-hole, p, the point at which the vertical line pierces the horizontal plane surface, o, and the center of the image of the Sun at culmination, c,—three points in these determining lines,—

must lie in and "determine" the local meridian plane. p is given directly.

A plumb-line, suspended so as to pass through the pin-hole, will hang free in the vertical line and give the point o.

To find the point c is a less direct and a much more difficult problem.

First find the centers of the several images of the Sun and draw a smooth curve (xy—Fig. 1) through them. Since, at culmination, the Sun is at the highest point in its diurnal arc, it follows that at that moment the center of its image is at the point in the curve xy nearest to the point o. This point, c, may be determined by direct measurement from o.

A more accurate determination of c, giving a much more accurate determination of the first four objectives of the experiment, may be made as follows:

The diurnal path of the Sun across the sky is symmetrical[1] with reference to the meridian plane. Its afternoon path is a reversed duplicate of its forenoon path. The horizon plane is perpendicular to the meridian plane. Therefore the curve of centers of the images, xy, must also be symmetrical with reference to the meridian plane. The point o lies in both planes. If, with o as center, and any convenient radius, arcs be drawn intersecting xy in two points, m and n, these two points will be symmetrical with reference to the meridian plane. If now, with m and n as centers, two intersecting arcs be drawn, their point of intersection, d, must lie in the meridian plane. Therefore do must lie in the meridian plane, and its intersection with xy must be c, the center of the image of the Sun at culmination.

The Experiment

Apparatus: Beside the special piece of apparatus shown in Fig. 3, the experiment requires a copy of the Nautical Almanac for the current year, an accurate plumb-line, a spirit level, a watch set correct to the second, and a beam compass. (If no beam compass is available a steel tape may be used.)

Operation:

1. Select a southern window where no overhanging

[1]Exactly true at the Solstices, when the Sun's hourly motion in declination is zero. The error at other times is negligible with this apparatus.

roof, trees, or other obstruction can intercept the rays of the Sun.

2. Place a heavy table close to the window and wedge up under its legs until it is perfectly firm.

3. Place the special apparatus on the table with the pin-hole toward the Sun and with the longer dimensions of the horizontal plane surface approximately in the meridian. (The position may be determined by a rough preliminary experiment,—by the North Star,—or by the magnetic compass.)

4. Level up the horizontal plane surface with the utmost care. (The apparatus must not be moved until the Georgraphic Meridian has been found and the Declination of the Magnetic Compass determined.)

5. As soon as the image of the Sun appears on the horizontal plane surface, trace its outline lightly, carefully and quickly with a soft sharp pencil. It will make subsequent calaculations easier if the traces are made on the exact minute. Record the exact time to the nearest second. Repeat every ten minutes until the image passes off the working surface. (The window must be open while the traces are being made, to avoid refraction.)

6. With the plumb-line, determine, and mark o, the intersection with the horizontal plane of the vertical line through the center of the pin-hole.

7. Find and mark the center of each image and, using a light flexible ruler, connect these centers by a lightly drawn, smooth curve. (xy, Fig. 1.)

8. With o as center, draw arcs intersecting xy at two points, m and n, near the edges of the working surface.

9. With m and n as centers, draw intersecting arcs. This point of intersection is d—Fig. 1.

10. Draw do and mark its intersection with xy. This point, c, is the center of the Sun's image at culmination.

Results:

1. POC is a segment of the local meridian plane (Fig. 1) and therefore co, its intersection with the horizon plane, is a segment of the local Geographic Meridian—the first objective of the experiment. (Suggestion: Mark this meridian in the room. A wire overhead or a line on the floor would make a permanent record. Plumb-lines may be used to locate this marker.)

2. Place a magnetic compass with the N-S line of its scale in the local Geographic Meridian and read the local Magnetic Declination,—the second objective of the experiment.

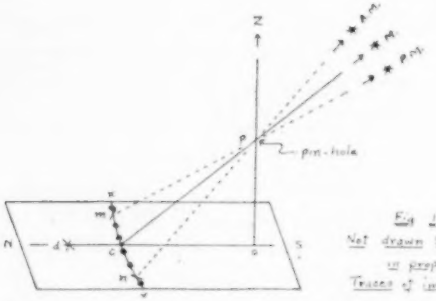


Fig. 1.
Not drawn to scale, nor in proportion.
Traces of images not shown.

3. It is very improbable that a trace of the image of the Sun will have been made at Apparent Sun Noon. The standard times of the next preceding and the next following traces will have been recorded, however, and from these calculate, by interpolation, the Standard Time of Apparent Sun Noon—the third objective of the experiment.

4. From the Nautical Almanac get the "equation of time" for the day of the experiment. Calculate the standard time of Apparent Sun Noon for the meridian whose "mean time" is used in the experiment. The difference between this and the local time, as determined in the experiment, is the difference in time between the standard time meridian and the local meridian. From this calculate the difference in longitude between the two meridians,—4 minutes difference in time indicating 1° difference in longitude. This difference is to be subtracted from the longitude of the standard time meridian if Apparent Sun Noon is earlier at the place of the experiment; added, if it is later. The result will be the Longitude of the Observer,—the fourth objective of the experiment.

5. Fig. 2 is drawn in the observer's meridian plane. O is his position, and H-H the horizontal plane at o. Z is his zenith, and S the position of the Sun. "Decl." is the declination of the Sun at the time of the experiment. The observer's latitude, "Lat.," is equal to the algebraic sum (North declination considered +, south declination –) of the zenith distance of the Sun, D, and its declination.

Fig. 1 shows that D, $\angle$ ZPM, is equal to $\angle$ CPO.

$$\tan \text{CPO} = \frac{\text{OC}}{\text{OP}}$$

$$\therefore \tan \text{D} = \frac{\text{OC}}{\text{OP}}$$

Measure OC and OP and calculate D. (Correction for refraction is unwarranted unless the noon-day Sun is very low,—less than 20° above the horizon.)

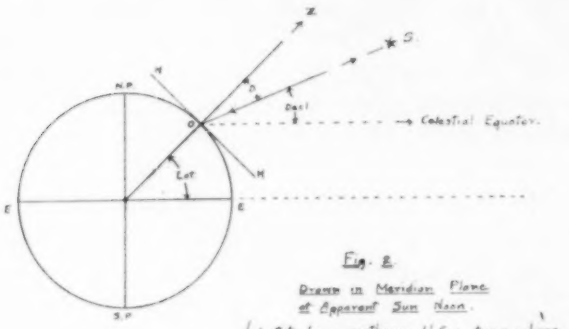


Fig. 2.
Drawn in Meridian Plane at Apparent Sun Noon.
(Latitude, - northern U.S.; time: June.)

From the Nautical Almanac get the declination of the Sun, "Decl.", and correct this for the observer's longitude; the Almanac gives the "hourly motion in declination."

The algebraic sum of D and "Decl." is the Latitude of the Observer,—the final objective of the experiment.

An Extension of the Experiment.

By conducting a series of experiments extending through the year, the observer could also obtain:

1. The graph of the standard time of Apparent Sun Noon, and

2. The graph of the Zenith Distance of the Sun at Culmination.

The second graph would give:

a. The approximate dates of the Equinoxes and the Solstices.

b. The Inclination of the Earth's Axis.

c. The width of the Sun-Light Zones.

d. The Latitude of the observer,—without the correction for declination—by using the mean value (half sum of the values at the solstices) of the zenith distance.

THE SPECIAL APPARATUS—SUGGESTIONS AS TO THE CONSTRUCTION AND DIMENSIONS

Plate. A sheet of stiff brass 30x15 cm. bent across the center at an angle equal to 90° plus the latitude of the observer.

Pin-Hole. Diameter, at lower surface of plate, 1/16 of an inch, reamed out at a very wide angle (enlarged sketch, Fig. 3).

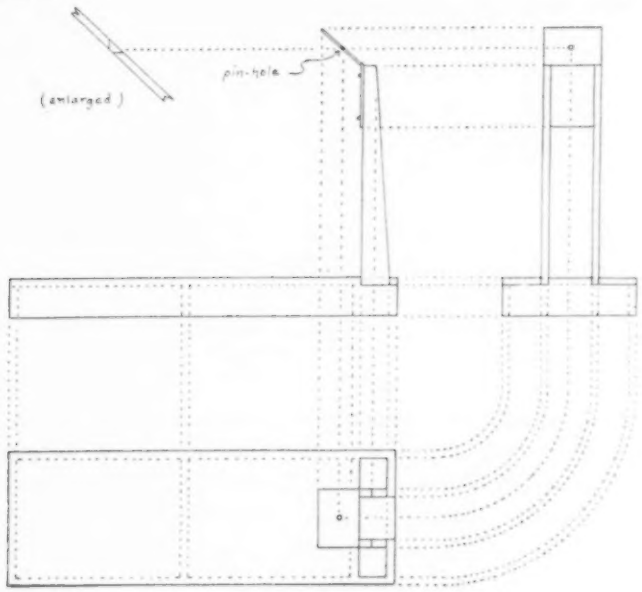


Fig. 3
Scale 1/10 - metric.

Height of the Pin-Hole. (po Fig. 1.) From center of pin-hole in lower surface of brass plate to horizontal plane surface, 60 cm.

Support of Plate. Two uprights. The open space between allows an unobstructed view for "sighting" the geographic meridian (N – S Fig. 1).

The Horizontal Plane. This surface must be as perfect a geometric plane as possible. The boxed frame shown by dotted lines will reduce the danger of warping. Its width should be about 35 cm. and its length will depend upon the values of oc which the experiment will give. (At latitude 43° 30′ and with po = 60 cm. oc will be 21.8 cm.

at the summer solstice, 56.9 cm. at the equinoxes, and 141.4 cm. at the winter solstice. OC = po tan (Lat. – Decl.) Determine the over-all length of your own apparatus.)

Leveling Screws. Desirable, but not indispensable.

Brass screws should be used in building the apparatus, if the Magnetic Declination is to be found.

Alternative Apparatus

If the floor of the school room is reasonably plane and level, and free from fixed obstructions, it may serve as the horizontal surface. The brass plate may be rigidly fastened to the window seat, or to a cleat screwed to the window frame. The plate must project into the room so that the vertical line, po, shall extend, unobstructed, to the floor. To secure a sufficiently bright image of the Sun, a slightly larger hole may be necessary. (perhaps 1/8″)

Some advantages of this alternative apparatus:

a. Much simpler construction.
b. Greater ease of observation by large classes.
c. No troublesome re-setting of the apparatus.
d. Permanence of the geographic meridian and pin-hole throughout the year.
e. Larger values of po and co.

If the working surface of the apparatus is left unvarnished, drawing paper may be stretched upon it,—drum-head tight,—and the paper renewed whenever a fresh surface is needed.

The apparatus here presented has several points of superiority over the historic gnomon.

1. *The line po must be vertical* (Fig. 1). In the gnomon, po is the axis of the upright shaft. To so place and secure this shaft that its axis shall be rigidly and permanently held in position exactly perpendicular to the horizontal or working surface is a task requiring the skill of the best mechanic. In the apparatus here described, po is the line of direction assumed by a freely suspended plumb-line. It does not need to be built in. It is self adjusting. The point o is visible, accessible, and determined with absolute accuracy.

2. *The line xy must be located as accurately as possible.* With the gnomon, xy is the path of the shadow of the apex of the upright shaft. The indistinctness caused by the

penumbra is so great that reasonable accuracy is impossible. The shadow is materially shortened and the value of co diminished. With the apparatus here described, xy is the path of the center of the pin-hole image of the Sun. The definition of the image is perhaps no sharper than the definition of the shadow of the gnomon, but the indistinct band extends evenly around the edge of the image and does not affect the position of its center, c, nor make its determination less accurate. The true value of co is obtainable.

3. *co and po must be measurable with accuracy.* In the gnomon, o is invisible and inaccessible in the base of the irremovable shaft, and the measurement of co and—to a lesser degree—of po can be, at best, but approximately accurate. In the apparatus here described, o is easily and accurately determined and marked, and nothing interferes with the accurate measurement of co and po.

Accuracy obtained. The results obtained with a home made model of this apparatus in a series of experiments extending over a period of five years gave maximum errors of 14 seconds in the time of local Mean Sun Noon and 4 minutes in the Latitude. The classes were composed of older pupils of very limited laboratory experience. The experiments were performed by the pupils under the teacher's immediate supervision, as "class experiments." The single trigonometric calculation was made by the teacher.

ENTOMOLOGISTS MAKE WAR!

A new enemy is the citrus, or Mediterranean, fruit fly, a deadly foe to growing oranges, which has been discovered recently in the Florida orange groves. So serious is the menace to the country at large if the insect is allowed to spread, that Congress appropriated $4,250,000 to fight it.

The fruit fly is a small insect about the size of the common house fly. It seems insignificant to the eye, but it is one of the most dreaded insect enemies man has to fight. Entomologists are embattled against this winged pest; they will annihilate it in the United States, if it is possible to do so.

An entomologist is a student of insects. In the federal Department of Agriculture the chief duties of the entomologists are fighting and controlling the insect enemies of crops. Entomology is a Greek word. The first part of the word comes, according to Webster's New International Dictionary, from the Greek word for insect; in the Greek it means "cut in two," the insect being so named because it often has that appearance, one part of the body being extremely thin. The last part of the word means "the subject of," from the Greek logos, "a speaking or saying." It is familiar as the ending of the names of various subjects, as zoology, geology, meteorology, etc.

CHEMISTRY EXPERIMENT AS THE BASIS FOR STUDY OF FUNDAMENTALS.

By G. T. FRANKLIN,

Lane Technical High School, Chicago.

The meaning of such terms as "valence," "formula," etc., is acquired slowly and their full significance only mastered after much time and study. The acquisition of chemical principles is a growth. The futility of attempting to teach the meaning of these terms in one or two formal lessons, is obvious. The ideal situation is obtained when the pupil grows into the use of chemistry fundamentals without being conscious of just when it all happened. When the pupil begins to use formulas to interpret chemical reactions, it should be perfectly natural for him to do it the right way. Of course this is idealistic, but to have a goal to which some people attain is part of the system by which things are done.

In a paper read to the Chemistry Section of the Central association of Science and Mathematics Teachers November, 1926, and published later,[1] the writer discussed methods by which the background of the pupil's knowledge could be enriched in the preparation for formal study of valence. This paper suggested the use of such experiments as the electrolysis of water, equivalent weights by replacement methods, replacement reactions in general, as the basis for ground work on the nature of the force holding atoms together to make molecules, how the force varies with different elements, how many atomic weights of hydrogen are replaced by one atomic weight each of such metals as sodium, magnesium, aluminum, zinc, all of which yield readily to experimental treatment. A discussion of the paper was made by R. E. Davis in which he pointed out briefly that a continuance of the idea might be made to include some experimental work adapted to high schools, such as the derivation of a few formulas. The main purpose of the present paper is to discuss in some detail the nature of the method and outline plans by which it can be carried out efficiently and to the purpose.

The formula of tin oxide is readily determined experimentally by oxidizing a weighed quantity of tin foil with concentrated nitric acid. If the acid is added, a drop at a

[1] This Journal, 27, 4, p. 414 (April, 1927).

time, it is easy to determine when the end of the reaction is reached by the cessation of the fumes of nitrogen peroxide. The tin crumbles to a fluffy mass and need not be more than moist with excess acid. If this is carried out properly, there will be no danger of splattering when heat is applied to decompose the nitrate. If too much acid is used, heating from the top until the mass appears dry, will accomplish the purpose very well. The slow process of a water bath is not necessary. If strong heat is now applied the fumes of nitrogen peroxide appear and when they cease, it indicates that the reaction is ended and ready to be completed by weighing. The experiment is neat and requires only reasonable care to obtain acceptable results. It is handy for the teacher to have at hand squares of tin foil, weighing between one and two grams. If a record is kept of the size of the tin foil given the pupil, a check on the accuracy of his weighing may be made. To be able to point out to the pupil, who has obtained poor results, just where his mistake is, may avoid a continuance of the error when the experiment is repeated.

If a good grade of nickel in the powdered form can be obtained, the combination of it with sulphur makes another good experiment for the beginner. The method of carrying it out is simple and it needs no further comment except in what is to follow.

The derivation of the formula of the compound obtained by burning copper in sulphur, offers another interesting experiment of this character. It is used by some to find "the combining ratio of copper and sulphur."[2] The writer has used it several semesters and finds it one of the most interesting experiments adapted to the purpose in view. Before assignment to class, it was tried with various forms of copper such as sheet copper, copper wire No. 36, copper wire No. 30. They all gave the same results. Wire No. 30 was adopted as the size most convenient to use. A triple beam balance, weighing to one-hundredth of a gram does quite well. About two meters of the wire make a convenient quantity to use with a small crucible. About one gram of sulphur in powdered form is quite sufficient.

How shall we instruct pupils to do experimental work of this character? There appear to be two methods of writing

[2]Journal of Chemical Education, Charles H. Stone, 5, 9, (Sept. '28).

instructions, both of which are needed, depending upon the conditions, previous training of the pupils, the nature of the experiment, etc. The most popular method seems to be one in which instructions are much detailed, blank spaces left to be filled in by the pupil, tables to be completed, etc. The method has decided advantages in that it requires the pupil to follow a definite, logical procedure. It enables the teacher rapidly to check the work of the pupil. The other method merely states the problem and briefly outlines the procedure, leaving many details to be worked out by the pupil. The method requires the pupil to decide for himself the best selection of equipment adapted to the experiment to be done. He must decide for himself the method of making calculations, the general arrangement of the notes, etc. The method requires closer supervision on the part of the teacher, individual attention to the poorer students, and more oral discussion preceding the experiment. As a basis for further discussion, I am including a copy of an instruction sheet recently used.

TO DETERMINE THE FORMULA OF A COMPOUND OBTAINED BY BURNING COPPER IN SULPHUR.

Weigh a clean crucible and record the weight as indicated below. Add one or two grams of copper wire to the crucible and weigh, recording the weight as before. Place the crucible in a clay triangle and mount on a ring-stand. Cover the copper with about one gram of powdered sulphur. Cover the crucible and apply heat. When the crucible is red hot, remove the cover and continue to heat until you are sure all excess sulphur is removed. When cooled somewhat, weigh the crucible and its contents, recording the weight as usual. Complete the work as outlined below.

Wt. of crucible and copper .....
Wt. of empty crucible.....
Wt. of copper used .....
Wt. of crucible and compound.....
Wt. of sulphur combined with the copper .....

$$\frac{\text{Wt. of Copper}}{\text{Wt. of Sulphur}} = \frac{x}{32} \cdot x = \text{_____}.$$

$$\frac{\text{Value of x}}{\text{Atomic Wt. of Copper}} = \text{_____}.$$

One atomic weight of sulphur combines with ..... atomic weights of copper.

The formula of the compound is .....

Calculate the percentage composition of the compound, using the data in your table, and from this verify the formula obtained by the above method.

QUESTIONS.

How many grams of copper are equivalent to sixteen of sulphur or one of hydrogen?

What is the ratio between the equivalent weight of copper and its atomic weight?

Complete the formulas of the following ions: H, O, S, and Cu.

Although the method of deriving a formula from percentage composition had been worked out in the classroom preceding the experiment and some drill exercises done, the number that failed to do this part acceptably was large. Had the work been outlined in the same manner as the other method, the number would have been greatly reduced. It is not the purpose of the writer to argue what method ought to be followed. Some facts are being given, leaving the reader to formulate his own conclusion.

The experiment was given after equivalents by replacement methods were used and the formulas of a few ions established on the basis of the experiments. In this experiment, the formulas of the ions were written very well except the copper, suggesting that some had used their books for the information instead of the experiment data. The questions are applicable to any experiment of this type. How to stimulate the pupil to use experimental data to solve problems is something to be worthy of seeking.

Some criticisms have been offered and answered as to the fitness of this problem.[3] This makes it all the more interesting in that the teacher may make the problem more realistic by announcing that some of the books differ as to just what the formula is and that it is their business to find out. It is interesting to note that cupric sulphide decomposes at 220° C.[4] The reaction takes place at much higher temperatures. If any cupric sulphide is formed at the beginning of the reaction, it is decomposed by the heating afterward. There is no evidence that any copper oxide is formed during the heating to remove excess sulphur. The important thing about the experiment is, it works very well.

Outside of the main purpose of the problem, there are other things that may be clarified and fixed in the mind of the learner. Some pupils ask as to whether the quantity of sulphur used makes any difference. This means that they do not understand the law of definite proportions and this is appropriately reviewed at this point. Many do not understand the meaning of "combined sulphur." Chemical changes receive more treatment with the result that some pupils may understand the idea for the first time. Experiments of this kind bring the pupils into closer contact with

[3]Journal of Chemical Education, Chas. H. Stone, 5, 9, p. 1129 (Sept. 1928).
[4]Handbook of Physics and Chemistry, Hodgman-Lange, Thirteenth Edition.

the science. They tend to nullify the impression that chemical formulas are derived in some mysterious way far beyond their comprehension—something to be accepted without comment or question.

A SUGGESTED ONE-YEAR BIOLOGY COURSE.

By Lillian Banderant,
Oak Park, Ill.

I. Introduction
- A. Definition of Biology
  1. How things live
  2. How they are related to one another
  3. How they depend upon the world about them
  4. Man's control over them

II. Animal Life (One-Third Year)
- A. Protozoa
  1. Amoeba
  2. Paramecium
- B. Insects
  1. Classification of
  2. Life history of several typical ones
- C. Crustaceans
- D. Fish
- E. Amphibians
- F. Reptiles
- G. Birds
- H. Mammals

III. Human Life (One-third Year)
- A. Physiology
  1. Systems of the body
     - a. Bony
     - b. Muscular
     - c. Digestive
     - d. Circulatory
     - e. Excretory
     - f. Nervous
- B. Hygiene
- C. Genetics and Eugenics

IV. Plant Life (One-third Year)
- A. Plants that contain Chlorophyll
  1. Cell study
  2. Parts of the plant
     - a. Leaf
     - b. Stem
     - c. Root
     - d. Flower
     - e. Fruit
     - f. Seed
  3. Trees
     - a. Lumbering
     - b. Forest products
- B. Plants that lack Chlorophyll
  1. Mushrooms
  2. Yeast
  3. Mold

SOME COMMON SNAKE STORIES.*

BY A. I. ORTENBURGER,

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Without much doubt more untrue stories are told and firmly believed about snakes than about any other group of animals. I do not wish to indicate by this that all of the common stories about many other vertebrate animals are true but merely that, with the possible exception of fish stories, the wild and impossible yarns told about snakes are much more fantastic than is ordinarily imagined. Most people have at some time or other heard about the Hoop Snake and its effect upon such stable, living things as large trees; the Milk-snake and its danger to the dairy industry; the marvelous deadliness of the Puff Adder or Spreading Viper; the Joint "Snake" or Glass "Snake"; the Whip Snake; the ability of snakes to charm their prey; the many stories about the Rattlesnake; man's instinctive fear of snakes; snakes which swallow their young; and so on nearly *ad infinitum*. There is probably little exaggeration in the statement that practically all snake stories that one hears from the layman have no basis in fact.[1] It should be worthwhile, then, to consider some of the commoner stories and to attempt to explain their origins or, at least, why they can not be regarded as plausible.

The Hoop Snake story is, of course, a very old one and is steadfastly believed by many people. One of the most interesting scientific papers whis has appeared within the last few years, is one concerned with the Hoop Snake story. It was written by Mr. K. P. Schmidt and was published in *Natural History*.[1]

Strangely enough, there seems to be no European snake story corresponding to it. Several early American accounts are found; apparently the earliest of these is dated 1688—a letter written by John Clayton to the Royal Society of London.[1] The snake usually referred to as a Hoop Snake actually is a handsomely colored snake of medium size called the Rainbow-snake *(Abastor)*. Dark colored or black above, with brilliant scarlet stripes, it forms a good subject for a snake story, particularly since it is so seldom seen;

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*Contribution from the Zoological Laboratory of the University of Oklahoma, Second Series, No. 101.

it burrows in the soft mud and is usually found in sparsely inhabited regions.

One always runs the risk of offending many people when such stories as this are contradicted flatly and without question. Particularly in the southeastern part of the United States many people would be willing seriously to swear to the fact that they had seen a Hoop Snake and had seen it in action. Possibly the habit of certain other snakes, like the Black-snake *(Elaphe)*, of gliding at a relatively high speed over the tops of bushes gives the casual observer the idea that the snake is indeed a large reptile which has formed a huge hoop and is rapidly covering the ground in this fashion.

With the Hoop Snake story is usually associated the idea that certain snakes are "stinging" snakes. This story arose from the fact that certain snakes, notably the Horn Snake *(Farancia)*, when handled use the sharply pointed and horny tipped tail with which to explore and feel, thus giving rise to the belief that the snake is stinging the person handling it. Moreover, when such a snake is examined after it is killed, the little horny tip of the tail is always noted; it is assumed that like the scorpion, this is actually a stinging apparatus. Nothing could be so far from the truth, for this modified tail is not even hollow like a sting; it is a solid pointed scale which covers the end of the tail, within which there is no poison apparatus at all.

The story of the Milk-snake is one which is widely known and generally believed.[3] Apparently all sub-species of the true Milk-snakes *(Lampropeltis triangulum)* and certain others *(Pituophis)* are accused of sucking milk from cows. Great numbers of individuals are positive that they have actually seen this take place. Milk-snakes, because of their fondness for mice and rats, frequent the dwellings and barns on the farm and are quite often seen by people; for some reason or other, possibly because of the fact that on rare occasions they may have been seen to drink milk from the saucer set out for the family cat, they are accused of taking this same sort of food in a much more direct way. In this connection, it should be pointed out that while snakes normally eat quite seldom, they must obtain water quite regularly. This will easily account for their drinking milk from a shallow container when they come upon it, particu-

larly if during a dry spell water in natural sources happens to be scarce. Anyone who has lived on a farm and knows cows realizes that there are many causes for sudden changes in the flow of milk, but the common though erroneous idea is that when a cow fails to give its usual amount of milk a Milk-snake has been busy sucking the milk. It is a queer thing that this story does not take into account the fact that because of the many teeth in a snake's mouth, each one of them as sharp as a needle, the cow would most certainly never stand still and allow the snake to drain the udder. Since the bite of a Milk-snake is entirely harmless, any person who doubts this statement may easily convince himself by putting his finger in a Milk-snake's mouth, allowing the many needle-like teeth to penetrate the skin. This will convince *anyone* that a cow would not allow itself to be milked by any snake. In addition to these facts, the amount of milk that a Milk-snake could drink would be relatively small as compared to the amount given by a cow at a single milking.

The Joint-snake or Glass-snake story is another one commonly heard. The essence of this story is that the Joint-snake, when struck or injured in any way, will fly to pieces and that later these pieces will reunite, forming a new Joint-snake just as good as the old one; the animal will then crawl away and live happily ever after, or at least until it is necessary to fly apart and reunite itself another time. The main difficulty with this snake story lies in the fact that the Joint-snake is not a snake. The so-called Joint-"snake" *(Ophisaurus)* actually is a lizard. Only two very obvious characteristics need be mentioned to convince anyone of this fact. First, it has eyelids, and second, external ear openings; snakes have neither. However, the story is worthwhile considering even though the animal is not a snake. It is true that if such a lizard is handled roughly, is stepped upon or is struck with a stick, it ordinarily will break off a part or most of its very long tail and this piece, or pieces, will, due to nervous stimulation, continue to wiggle and squirm very violently for some time. In this way the attention of the person attacking the animal is drawn to the broken pieces of the tail and the lizard itself, minus its tail, will then crawl away to safety. A new but shorter stub tail is developed later.

Suffice it to say, the piece or pieces of the tail broken off at will by the lizard can not grow back together and do not grow into a new lizard. These lizards are quite remarkable from a zoological standpoint, in that they possess specialized parts which allow the muscles of the tail to act with such violence that the animal may break off its own tail.

The so-called Glass or Joint-snake is of further interest, zoologically, in that it has no external legs; it is for this reason that it is commonly thought to be a snake. Other lizards, of course, are known which have no fore legs *(Pygopus)* and still others are without hind legs *(Chirotes)*. On the other hand, it is equally true that some snakes actually possess small hind legs, notably the pythons and boas.

The story of snakes charming their prey is one which is widely believed but largely untrue. The idea probably arose from the fact that certain small animals, such as birds or mice, become so frightened when they see a snake that they are temporarily unable to move. I have seen this very thing in Oklahoma, along the banks of the Red River. I once came upon a large Pilot Black-snake *(Elaphe obsoleta confinis)* hanging over and into the hollow trunk of a dead tree. The snake was perfectly motionless and, in watching him at a distance of three or four feet, I found that he did not see me but apparently was looking intently at something within the cavity. This proved to be a small mouse which literally was "frozen" to the spot, apparently by fear, whatever that may mean. The position of the two animals was maintained for probably two or three minutes. Then, I moved forward to grab the snake, the "charm" was broken and both the snake and mouse suddenly regained their activity. In all probability some such situation as has been described explains all that there is to the many exaggerated and fanciful stories concerning snakes charming their victims, and even causing them to approach and conveniently enter the open mouth.

Another very prevalent and erroneous idea is that the fear of human beings for snakes is inherited. While my own observations on this point are not very extensive, I am amply supported by evidence from competent observers. In the case of my own youngsters and the children of several of my friends, I can say positively that they have never

exhibited fear of any snake of any kind or size at any time. One must however, in conducting such an experiment, be careful that the youngster has heard no remarks or seen actions which have prejudiced him or caused him to have any foolish fear of a snake. In all cases in my experience where the child knows nothing of snakes, he will immediately consider one, when handed to him, as an interesting thing to play with and the only danger noticeable is that the snake may be pulled in half or squeezed to death by the enthusiastic child. Most toys will not wiggle quite so energetically as a snake when roughly handled. I might say in this connection, that on one collecting trip it was necessary repeatedly to warn my four-year-old son not to pick up every snake he saw because of the fact that Rattlers were quite common where we were camped. I believe that there is actually no basis in fact for this wide belief in an instinctive fear of snakes.

Many discussions arise as to whether snakes lay eggs or whether they give birth to their young alive and many are the stories arising from this apparently contradictory pair of ideas. Actually both sides in this case are correct because some snakes lay eggs (for example, the Hog-nose and Blue Racer), and some snakes do not (Rattlesnakes and Gartersnakes).[2] Most reptiles, of course, do lay eggs and apparently this is true even for most of the huge reptiles such as the dinosaurs which once roamed the earth. This last fact was beautifully proven by the fossilized eggs of dinosaurs with the embryos inside of them that were found in the Gobi desert by the American Museum of Natural History Asiatic expedition of a few years ago. Snakes which lay eggs are called oviparous, while those which give birth to their young alive are technically called ovoviviparous. Actually there is little difference between the two types as in each case the young embryo derives its nourishment from the yolk of the relatively large egg. In the oviparous type the egg, with its large food-mass or yolk, becomes covered with a leathery shell and is laid relatively early; thus the embryo develops outside of the body of the mother snake. In the ovoviviparous type, no tough shell is developed and the egg is retained within the oviducts of the female snake. The young develops then within the body of the mother but receives, as in the other case, all of its

nourishment from the yolk. Finally, in this last type, the young are born alive. After all, then, there is little fundamental difference between the two types.

The Whip Snake story need be mentioned only briefly. There is, of course, no truth in the popular notion that flagellation of people is a common pastime of this well-known snake (*Masticophis*).

There is another question which is frequently discussed along with the commoner snake stories, and that is whether adult snakes (usually the mother) swallow their young when danger approaches. In most cases, if not all, it is assumed that this is done to protect the young from possible harm or injury. Of the many papers which have appeared on this subject[2,4,9,10] perhaps the one by K. P. Schmidt[5] is the most recent and the best general, unprejudiced account. Due to the contradictory nature of the evidence, for the present this question must remain unsettled; it should be viewed with an open mind, however difficult this may be. To the writer and many other herpetologists it appears now that this phenomenon is physiologically improbable, if not impossible; we must remember that the digestive juices are of such a nature that life could not continue very long in their presence. In all probability the story has had its origin in the fact that people killing snakes have not known that many snakes are ovoviviparous. When the bodies were smashed open in the process of "killing them dead," the fully developed young nearly ready to be born were thus liberated and enabled to crawl away. The immediate assumption was that they were in the stomach, whereas of course they were in the oviducts, as might be seen even in a casual examination. Many who are uninformed do not differentiate between the actual stomach and other organs within the body cavity, and in this way it would be easy to assume that the young snakes had been swallowed. In addition *most* of these stories are told about snakes which do not lay eggs but which are ovoviviparous, bringing forth their young fully developed. This fact further strengthens the explanation just given. Another point which should be mentioned is that many snakes feed largely upon other snakes and lizards. Someone who has seen a lizard or snake tail disappear down a snake's mouth has very probably concluded without further evidence that the

snake had swallowed her young. Thus most supposedly conclusive observations may easily be explained away. However it should be emphasized that at present we have no absolute proof on either side of the question, but so far the bulk of the evidence is negative. We await with interest indisputable proof that snakes do swallow their own young for reasons other than obtaining food.

Many are the stories concerning various methods of snake bite treatment but the commonest of them all, has to do with the excellence of giving large over-doses of whisky, brandy, or other strong alcoholic to the person who has been bitten. To the average person a snake bite is a snake bite and always poisonous. However, as most snake bites are those of harmless snakes, the miraculous "recoveries" from snake bites due to the administration of whisky are told and retold. Little need be said in this connection except to give the facts of the case. In all cases where a person has been bitten by a poisonous snake such as a Rattlesnake or a Copperhead, the administering of an alcoholic stimulant cannot but be harmful because of the fact that the preliminary stimulating effect of the alcohol is soon followed by a depressing effect which furthers instead of hinders the action of the venom. Only one treatment of any consequence is known today for poisonous snake bites; that is the specific treatment with an anti-venin serum.[1] As this is to be discussed in a future paper nothing more need be said concerning it here.

Rattlesnake stories are much more numerous even than the different kinds of Rattlesnakes. We should first point out that not all snakes which are heard to "rattle" are Rattlesnakes. Many snakes have the habit, when frightened or disturbed, of rapidly vibrating the tail; if this happens to occur among dead leaves or other similar dry material, the noise produced will often make the uninitiated feel certain that he has narrowly escaped death from a Rattlesnake bite. The author has often been momentarily stopped in his tracks by this very thing. Also, on numerous occasions, in certain parts of the United States, the same thing has resulted from the rattling of the seed pods of certain legumes when brushed against. Most Rattlesnakes, incidentally, do not rattle even when disturbed. The old idea that the Rattlesnake is at least something of a gentleman

because he gives warning before he strikes is only partially true. From personal observations in the Arizona desert, only about 4 per cent of the many Rattlesnakes encountered rattled even when disturbed.[4]

Like most other ideas concerning Rattlesnakes, the one that age can be determined by the number of rattles is erroneous. Briefly, if all rattles are present, and this is commonly not the case, the number merely indicates how many times the snake has shed his skin. This depends largely on how much the snake gets to eat; hence the number of rattles is no indication of the snake's age. Moreover, rattles are lost by the snake very easily; I have seen a large Black-tailed Rattler in the Santa Catalina Mountains in Arizona lose half of his rattles merely by pulling his tail from under the weight of his own body. There are other false ideas such as the one that Rattlesnakes strike themselves and thus commit suicide; that they will not cross a horse-hair rope or even a white line; and that they live in peace with the small mammals, such as the ground squirrels and prairie dogs.

This short résumé of snake stories would not be at all complete without some stories dealing with a snake which has many diverse common names such as Blow Snake, Spreading Viper, Spreading Adder, Puff Adder, Blowing Viper and so on.[2] The only really good common name, because of the fact that the others are misleading, is the Hog-nose Snake. This particular snake *(Heterodon)* has possibly the worst reputation of all North American snakes and the least grounds for such a reputation. It is perfectly true that it does flatten out its body and that it does blow, but it is one of our *entirely* harmless snakes.[5] The only known fact against it is that it lives entirely upon toads, which are beneficial animals. When frightened, this snake presents a terrifying appearance but that is all. When it blows, it merely blows the air out of its lungs and once more that is all. It is, of course, supposed to blow a very poisonous and deadly venom which causes the victim at a distance of many feet at least to become blind or to have convulsions of the worst sort and die. Nothing could be further from the truth, as the Hog-nose Snake has no venom whatsoever. This snake runs keen competition with many a college student, for it is a past master at bluffing. It is literally a

marvelous bluffer, for it will flatten its body, go through a series of contortions, blow through its nose and even strike; yet is absolutely harmless. Although its teeth could do no more damage than a needle prick, it does not even open its mouth when it strikes. When annoyed, it commonly plays dead by rolling over on its back and letting its mouth hang open with the tongue dragging on the ground. After some minutes, if the observer stands perfectly quiet, it will be seen to "come to"; it carefully turns over, looks around and then glides away. Some snakes actually do blow poison, notably one of the African cobras; in this case, if the poison spray strikes the eye at least a severe irritation results.

It should be obvious that the common and well-known snake stories of this country are based upon next to nothing as far as facts are concerned and that one is quite safe simply in not believing any of them.

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[4]NOBLE, G. K. 1921. Do Snakes Swallow Their Young for Protection? Copeia, No. 98, pp. 54-57. (A list of ten papers on this subject is given with this article.)

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[9]SPECK, F. G. 1918. Testing Folk-lore by Observations on Butler's Garter Snake. Copeia, No. 57, pp. 56-60.

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In mathematics he was greater
Than Tycho Brahe, or Erra Pater;
For he, by geometric scale,
Could take the size of pots of ale.
—*Samuel Butler, "Hudibras."*

THE INDIVIDUAL LABORATORY METHOD OF TEACHING PHYSICS WHEN NO PRINTED DIRECTIONS ARE USED.

By C. H. Walter,

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Articles[1] have appeared from time to time in this Journal in regard to the relative merits of the teacher demonstration and individual laboratory methods of teaching science. The April number gives reference to a thesis written by myself. At the conclusion of my thesis and since that time I have believed that the fact has been thoroughly established that the teacher demonstration is superior to the individual laboratory method as it has been administered by teachers in the past—at least for imparting immediate knowledge.

All of these theses, including my own, have been weak in that they did not explain fully enough the exact procedures followed. In my own and very likely in other individual methods the pupils followed printed directions under supervision of the teacher. It was supposed that only one variable existed in addition to the time element, namely who performed the experiment, the teacher or the pupil. After completing my thesis I have come to the conclusion that there was in these experiments a greater variable, the attitude and trend of the pupil's thought while the experiment was being performed.

When the teacher demonstrated the experiment everything done led the pupil's thought directly toward the end or result sought. When the pupil performed the experiment he took each step in the operation as an end in itself. To be specific I might refer to the experiment on finding the density of steel as outlined in the manual of Millikan and Gale. The pupil spent three times as much time in removing bubbles from under the glass cover of the brass cylinder as he did in getting the weight of the displaced water. He naturally remembered this incidental operation more vividly than he did the one essential in finding the volume and ultimately the density of steel. When the teacher demonstrated the experiment the ultimate goal was not clouded in this way as no bubbles were allowed to enter. The pupil was led in his thought slowly but steadily toward one goal. When the pupil performs the experiment he is thinking more largely of how to get done what the book directs him to do so that he may present the figures the teacher wants and get the credit he wants toward the diploma which is his ultimate goal.

[1] School Science and Mathematics: Vol. XXIX, No. 1.

Taking as a norm the superior results of the teacher demonstration I have spent two years since 1926 in studying individual procedures which would necessitate the pupil keeping his thought directed toward the problem to be solved in the experiment, and if possible improve on the achievements of former years. I succeeded in this but in comparing with 1925 results I could not be sure that this improvement was not due to better preparation in mathematics, general science or in improvement of the general attitude toward school work from year to year.

In 1929 I again arranged an experiment by which these methods could be carried on simultaneously and as many such variables removed as possible. Three methods were used. Three distinct groups one for each method were not formed, but three groups worked an equal number of experiments by each method and the total results of each of these methods were compared.

In the tables these groups are designated by numbers in parentheses. The roman numerals refer to the experiments six in number. The first method I have called the Individual-Manual method in which the pupil follows the directions in the manual and performs the experiment individually under the direction of the teacher. In the second method called the Individual-No Manual the pupil was simply given the material and told to prove or test a law. He was given suggestions which with the apparatus supplied limited him to practically the same procedure outlined in the manual, and followed by the other groups. In the third method the teacher demonstrated the experiments as outlined in the manual. Each group worked two experiments by each of the three methods and in all cases the work was assigned as a problem.

It is readily seen that the pupil using the second method must have a conception of the law to be tested before he can start working. This same conception was given to all three groups alike but the Individual-Manual method did not require keeping this in mind and difficulties in securing accurate results or setting up apparatus could draw his attention away from the purpose and goal sought or from its place in the whole plan. The results are given in the tables on the opposite page.

It will be noticed that in each case, with one exception, the demonstration is found to be superior to the regular Individual Manual method but is surpassed by the Individual-No Manual method. The one exception is found in the boys' scores for the observation and memory tests. In this case the results of the

TABLE I—RESULTS IN ABILITY TO OBSERVE AND REMEMBER AS GAINED BY WORKING SIX EXPERIMENTS BY THREE METHODS.

Name of Experiment	METHODS								
	Whole Class			Boys			Girls		
	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method
I Density of cork	6.91 (3)	5.96 (1)	7.40 (2)	6.50	7.22	7.00	7.00	5.57	8.54
II Density of steel	4.40 (1)	8.10 (2)	6.00 (3)	5.00	8.25	5.20	4.28	7.54	6.86
III Resultant of forces	8.75 (2)	8.00 (3)	6.64 (1)	9.13	7.40	7.63	8.25	8.18	6.07
IV Pendulum	7.36 (1)	9.84 (2)	7.82 (3)	7.37	9.07	4.33	7.36	11.10	8.50
V Hooke's Law	8.77 (2)	9.19 (3)	9.32 (1)	9.06	8.89	9.63	8.30	9.33	9.14
VI Levers	5.18 (3)	4.96 (1)	5.59 (2)	5.43	4.78	5.94	5.07	5.07	5.09
Totals	41.37	46.05	42.77	42.49	48.61	39.73	40.26	46.79	44.20

TABLE II—RESULTS IN ABILITY TO THINK AS GAINED BY WORKING SIX EXPERIMENTS BY THREE METHODS

Name of Experiment	METHODS								
	Whole Class			Boys			Girls		
	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method	Ind. Man. Method	Ind. No. Man. Method	Teacher Dem. Method
I Density of cork	2.99 (3)	3.17 (1)	3.45 (2)	3.50	3.67	33.65	2.76	2.93	3.19
II Density of steel	4.25 (1)	4.25 (2)	3.90 (3)	4.55	4.19	4.20	3.30	4.00	3.29
III Resultant of forces	2.14 (2)	2.27 (3)	1.91 (1)	2.13	3.20	2.25	2.17	2.00	1.71
IV Pendulum	1.54 (1)	2.12 (2)	1.77 (3)	2.87	2.20	2.83	0.64	2.00	1.44
V Hooke's Law	2.12 (2)	2.48 (3)	2.32 (1)	2.44	2.00	2.64	1.60	2.67	2.14
VI Levers	3.09 (3)	3.75 (1)	3.56 (2)	3.29	3.78	3.38	3.00	3.73	3.82
Totals	16.13	18.04	16.91	18.78	19.04	18.95	13.47	17.33	15.59

teacher-demonstration method are below both of the others in value. I believe this is due to a very abnormal score of 4.33 for the boys of group (3). They scored over four points below the girls of the same group, an unusual occurrence. A larger number of cases would likely have absorbed such an exceptional score.

The time saved by this method is about one half that saved by the teacher-demonstration. The writer believes in curtailing but not eliminating laboratory work. The teacher is justified in demonstrating experiments involving the more expensive apparatus and where an unusually large amount of time is involved. The Individual-No Manual method seems to be best adapted to drill work where the pupil sees easily the meaning of the problem before he performs the experiment. The teacher-demonstration seems most appropriate where information is to be gained from the experiment. In using the former the teacher must be skilful in presenting the problem. The teacher should study the needs of his pupils, the cost of equipment, and the

time required and govern his methods accordingly. The method may be varied according to the choice of the pupils. A pupil who wants to get his hands on equipment should be allowed to do so. Probably a variety of methods will hold interest longer and better than any one used constantly.

The writer appreciates the limitations of the experiment presented and would hold final judgment until the work has been repeated by others.

PROBLEM DEPARTMENT.

CONDUCTED BY C. N. MILLS,
Illinois State Normal University.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to C. N. Mills, Illinois State Normal University, Normal, Ill.

LATE SOLUTIONS.

1078. *I. Wallach, Brooklyn, N. Y.*

1090. *A. E. Pitcher, Cleveland, Ohio; Howard H. Smith, Newburg, Iowa.*

1091, 1092. *R. Gopalan, Rangoon, India.*

CORRECTION.

January, 1930, page 81. *8th line from bottom should read*

$$\text{sum}(p/a)^2=(1-\cos Y)^2+[1-\cos(X+Y)]^2 \text{ etc.} = 3/2n.$$

The next line should read

$$(1-\cos Y)^2=1-2\cos Y+\cos^2 Y=3/2-2\cos Y+1/2\cos 2Y.$$

In the next lines

"3/2 should appear instead of 1/2."

SOLUTIONS OF PROBLEMS.

1097. *Proposed by the Editor.*

If $2\cos A=X+1/X$, find X. Then prove that

$$2\cos nA=X^n+1/X^n.$$

Solved by Orville A. George, Mason City, Iowa.

From $2\cos A=x+1/x$ we get $x^2-2x\cos A+1=0$.

Solving this quadratic equation gives

$$x_1=\cos A+i\sin A,$$
$$x_2=\cos A-i\sin A.$$

By DeMoivre's Theorem,

$$x^n_1=(\cos A+i\sin A)^n=\cos nA+i\sin nA,$$
$$x^n_2=(\cos A-i\sin A)^n=\cos nA-i\sin nA.$$

Hence,

$$x^n_1+1/x^n_1=\cos nA+i\sin nA+1/(\cos nA+i\sin nA),$$
$$=\cos nA+i\sin nA+\cos nA-i\sin nA.$$
$$=2\cos nA.$$

Similarly, $x^n_2+1/x^n_2=2\cos nA$.

Also solved by *Raymond Huck, Johnson City, Ill.; Agnes MacNeish, Chicago, Ill.; George Sergent, Tampico, Mexico; Clyde Bridger, Walla Walla, Wash.;* and *M. G. Shucker, Pittsburgh, Pa.*

1098. *Proposed by G. R. Ray, Sioux City, Iowa.*

At what time between nine and ten o'clock will the minute hand of a clock be as many minute spaces to the right of twelve as the hour hand is to the left of twelve?

Solved by Bessie Jordan, Hendersonville, N. C.

Let x = number of minutes past 12 for the minute hand to go.

$x/12$ = number of minute spaces past 9 the hour hand goes.

Since the minute hand is to be as far past 12 as the hour hand is behind 12, we have

$$x = 15 - x/12, \text{ hence } x = 13\ 11/13.$$

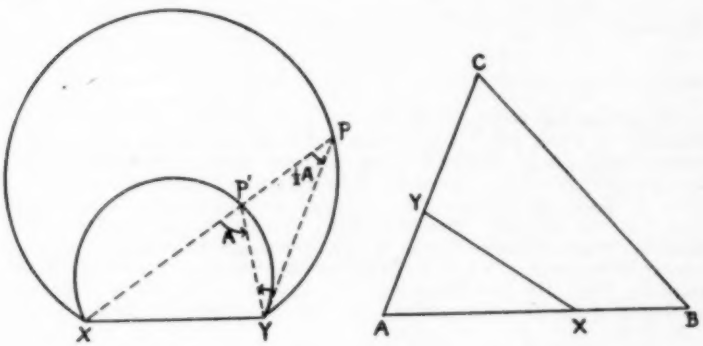
The time is 9:13 11/13 o'clock.

Also solved by *Hans Gutekunst, Batavia, Ill.; W. E. Buker, Leetsdale, Pa.; H. Grace Baird, Racine, Wis.; Hobson M. Zerle, Kingston, Pa.; Hazel Bryan, Perryton, Texas; O. K. DeFoe, Clarksville, Ark.; A. J. Paul, Chicago, Ill.; I. N. Warner, Platteville, Wis.; Frances P. Hennessey, Jamaica Plain, Mass.; Howard Roberts, Fayette, Mo.; Orville A. George, Mason City, Iowa; R. A. Patterson, Montreal, Can.; Walter Durding, Gettysburg, Pa.; Howard F. Fehr, Newark, N. J.; J. O. Austin, Thebes, Ill.; Agnes MacNeish, Chicago, Ill.; George Sergent, Tampico, Mexico; Joe McCarthy, Milton Vordahl, Spokane, Wash.; John Kuzma, James Loughman, Letesdale, Pa.; Morris Layton, Perrytown, Texas; R. T. McGregor, Elk Grove, Calif.; Sudler Bamberger, Harrisburg, Pa.; M. G. Shucker, Pittsburgh, Pa.;* and *D. de la Garza, Brownsville, Texas.*

1099. *Proposed by George Sergent, Tampico, Mexico.*

Given a triangle ABC, to place between AB and AC a line XY of given length, so that BX = AY.

Solved by Louise R. Chase, Newport, R. I.



Since AY + AX = AB, the problem may be solved if we can construct upon XY as base a triangle with the opposite angle equal to angle A, and the sum of the other two sides equal to AB. This may be effected as follows:

Upon XY as chord construct two circular arcs in which angle A and angle ½A, respectively, may be inscribed. In the outer arc apply chord XP = AB, cutting the inner arc at P'. Then angle P'YP = ½A, hence P'Y = P'P and XP' + P'Y = XP = AB.

In triangle ABC take AY = BX = P'Y.

Condition for solution: Diameter of circle $XPY \geqq AB > XY$.

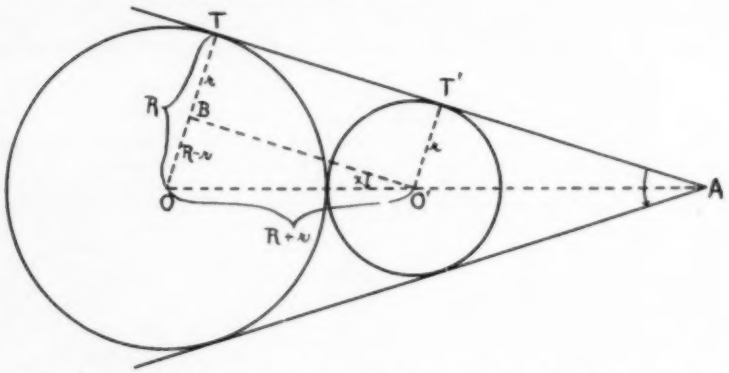
Also solved *F. A. Cadwell, St. Paul, Minn.; Grace Maude Custer, Franklin, Ind.; Howard H. Fehr, Newark, N. J.; A. J. Paul, Chicago, Ill.; N. A. Arsenief, Yaroslavl, U. S. S. R.;* and the *Proposer.*

1100. *Anonymous.*

Two circles whose radii are R and r touch each other externally. If A is the angle included between the common tangents to the two circles, prove

$$\sin A = \frac{4(R-r)\sqrt{Rr}}{(R+r)^2}.$$

Solved by Louis R. Chase, Newport, R. I.



In the figure, OA bisects angle A, angle x = angle $\frac{1}{2}$A and the triangles are right triangles.

By the Pythagorean theorem, $BO = 2\sqrt{Rr}$.

$$\sin x = \sin \tfrac{1}{2}A = \frac{R-r}{R+r}$$

$$\cos x = \cos \tfrac{1}{2}A = \frac{2\sqrt{Rr}}{R+r}$$

$$\sin A = 2 \sin \tfrac{1}{2}A \cos \tfrac{1}{2}A = \frac{4(R-r)\sqrt{Rr}}{(R+r)^2}.$$

Also solved by *George Sergent, Tampico, Mexico; F. A. Cadwell, two solutions, St. Paul, Minn.; H. Grace Baird, Racine, Wis.; Howard Roberts, Fayette, Mo.; Floyd Sheel, Assaria, Kansas; Walter Durding, Gettysburg, Pa.; Howard H. Fehr, Newark, N. J.; Agnes MacNiesh, Chicago, Ill.; Calvin L. Legg, DesPlaines, Ill.; Rudolph Jandl, Joe McCarthy, Spokane, Wash.; Bessie Jordan, Hendersonville, N. C.; Clyde Bridger, William Bashfield, Walla Walla, Wash.; R. T. McGregor, Elk Grove, Calif.; M. G. Shucker, Pittsburgh, Pa.; E. de la Garza, Brownsville, Texas; W. E. Buker, Leetsdale, Pa.; Mildred Hopkins, Montezuma, New Mexico; Frances B. Hennessey, Jamaica Plain, Mass.; and N. A. Arsenief,* and by *Yarsoslavl, U. S. S. R.*

1101. *Proposed by Norman Anning, University of Michigan.*

Find the eccentricity of an ellipse if its area is equal to that of the annulus bounded by its major and minor auxiliary circles.

Solved by Sudler Bamberger, Harrisburgh, Pa.

Where a and b represent the semi-major and semi-minor axes, we have

$$\text{Area of ellipse} = \text{pi}\, ab$$

$$\text{Area of annulus} = \text{pi}(a^2 - b^2)$$

Hence, $$ab = a^2 - b^2 = a^2e^2$$

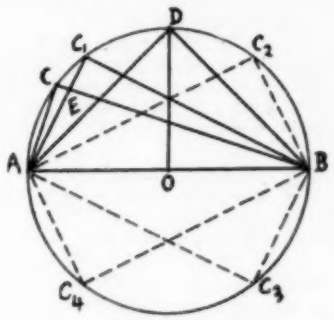
Therefore, $ae^2 = b$, and $b^2 + ab = a^2$. Solve this quadratic for b we get $b = 1/2(a\sqrt{5} - a)$. Hence $e = (1/2)\sqrt{2\sqrt{5} - 2)} = .79$.

Also solved *O. K. DeFoe, Clarksville, Ark.; George Sergent, Tampico, Mexico; Howard F. Fehr, Newark, N. J.; Louis R. Chase, Newport, R. I.; R. T. McGregor, Elk Grove, Calif.; Mildred Hopkins, Montezuma, New Mexico;* and the *Proposer.* One incorrect solution received.

1102. *Proposed by the Editor.*

Of all right-angled plane triangles having the same given hypotenuse, to find the one whose area is the greatest. Do not use Calculus.

I. *Solved by George Sergent, Tampico, Mexico.*



Geometric solution. The circle drawn on the given hypotenuse, AB, as diameter is the locus of the vertices of the triangles considered. Draw the radius OD $\perp$ AB. Let C be a vertex on the quadrant AD, and C_1 another vertex between C and D on the same quadrant. We have $<BAC > <BAC_1$; therefore AC_1 crosses BC. Let E be their intersection. The right triangles BEC_1 and AEC are similar. Since arc $BC_1 >$ arc AC, we have $BC_1 > AC$, $BC^2_1 > AC^2$, $\triangle BEC_1 > \triangle AEC$, $\triangle ABE + \triangle BEC_1 > \triangle ABE + \triangle AEC$; $\triangle ABC_1 > \triangle ABC$.

This shows that of any two right triangles inscribed in a half-circle, and having their vertices on the same quadrant of the half-circle, the one whose vertex is nearest the midpoint of the half-circle is the greatest. Therefore the $\triangle ABD$, whose vertex is the midpoint itself of the half-circle, is the greatest of all the right triangles having AB as hypotenuse and their vertex on the quadrant AD. This can also be proved directly by the same method as above, putting D in place of C_1,

If C_2, C_3, C_4 are symmetric of C_1, we have $\triangle ABD > \triangle ABC_1 = \triangle ABC_2 = \triangle ABC_3 = \triangle ABC_4$. We may now draw the conclusion that of all right-angled plane triangles having the same hypotenuse, the one whose area is greatest is the one whose vertex is the midpoint of the half-circle drawn on the hypotenuse as diameter, in other words, the isosceles right triangle.

II. *Solved by L. B. Southwich, West Palm Beach, Fla.*

The hypotenuse of a right-angled triangle will be the radius of a circle whose center coincides with the vertex of one of the acute angles.

Let the hypotenuse = R
the area = A
Angle at center of O = B.
The area of any $\triangle$ 15 $A = \frac{1}{2}bh$. Where b = base, h = altitude.
In a rt. $\triangle$ b = base
B = < at base.
then $b = R\cos B$ and $h = R\sin B$.
Substituting in formula $A = \frac{1}{2}bh$.

$$A = \frac{R^2 \cos B \sin B}{2}$$

As the sine increases the angle increases and the cosine decreases as the angle increases.

The point where the trigonometric function of the sine and cosine are equal will give the greatest area: sin of 45° = cos 45°.

The rt. $\triangle$ whose acute angles are 45° will give the greatest area.

III. *Solved by E. de la Garza, Brownsville, Texas.*

Let x and y be the sides of the right-angled triangle having a given

hypotenuse. Its area will be $\frac{xy}{2}$. For a maximum area this product xy must be a maximum.

$$xy = \frac{(x+y)^2-(x-y)^2}{4}.$$

The value of this expression evidently is a maximum when $x=y$. Hence the sides of the right triangle are equal.

Also solved by *O. K. DeFoe, Clarksville, Ark.; Floyd Sheel, Assaria, Kansas; A. J. Paul, Kansas; I. N. Warner, Platteville, Wis.; Hobson M. Zerle, Kingston, Pa.; Margaret Joseph, Milwaukee, Wis.; Howard F. Fehr, Newark, N. J.; Bessie Jordan, Hendersonville, N. C.; Hans Gutekunst, Batavia, Ill.; M. G. Shucker, Pittsburgh, Pa.;* and *H. Grace Baird, Racine, Wis.*

1103. *Proposed by W. E. Buker, Leetsdale, Pa.*

Find integral values of X and Y which satisfy the relation

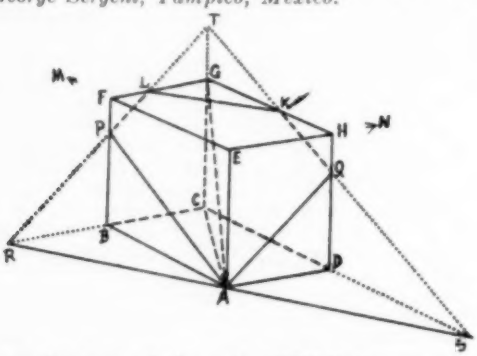
$$A^n+(A+1)^n+(A+2)^n+\ldots\ldots\ldots\ldots+(A+B)^n=(A+B+1)^n$$

No solutions received. *Hint:* $3^2+4^2=5^2$; and $3^3+4^3+5^3=6^3$. Find other solutions.

1104. *Proposed by Paul Mount-Campbell, Monte Vista, Colo.*

Find the volume of the solid resulting from cutting a ten centimeter cube by a plane. The cutting plane makes an angle of 45° with the base plane. The line of intersection of these two planes passes through a vertex of the base and is perpendicular to a diagonal drawn to this vertex.

Solved by George Sergent, Tampico, Mexico.



Let ABCD be the base of the cube, EFGH the opposite face. The line of intersection of the base and of the plane making an angle of 45 degrees with it, passes through A and is $\perp$ to GA, the diagonal of the cube. Let R and S be its intersections with the sides CB and CD of the base, produced. The edge GC being $\perp$ to the plane of the base, and the diagonal GA $\perp$ to the line RS in the same plane, the line CA which joins the feet of these $\perp$s, is $\perp$ to RS, by theorem.

Let the cutting plane intersect CG produced in T, the edge BF in P and the edge DH in Q, the edges FG and GH in L and K respectively. The solid cut off by the plane at 45 degrees is C-APLKQ. The volume of the solid E-APLKQ may be calculated directly by means of similar pyramids.

In the isosceles right triangle ACT, CA = CT, and $GT = a\sqrt{2}-a$. In the isosceles right triangle RCS, CR = CS = $2a$.

$$\frac{\text{Vol. T-LGK}}{\text{Vol. T-RCS}} = \left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)^3 = \frac{10-7\sqrt{2}}{4}.$$

Since BR/CR = DS/CS = 1/2, each of the pyramids P-RBA and Q-SDA equals $a^3/8$, and their sum is 1/4 of the pyramid T-RCS. Then the volume of the solid considered $\frac{7\sqrt{2}-7}{4}$ of the volume of the pyramid T-RCS.

The volume of T-RCS is $(2a^3\sqrt{2})/3$; hence the volume of the part of the cube between the base and the cutting plane is

$$(7a^3/6)(2-\sqrt{2}).$$

When $a=10$, this is equal 683.42.

The volume of the solid cut off (E-APLKQ is equal to 316.58.

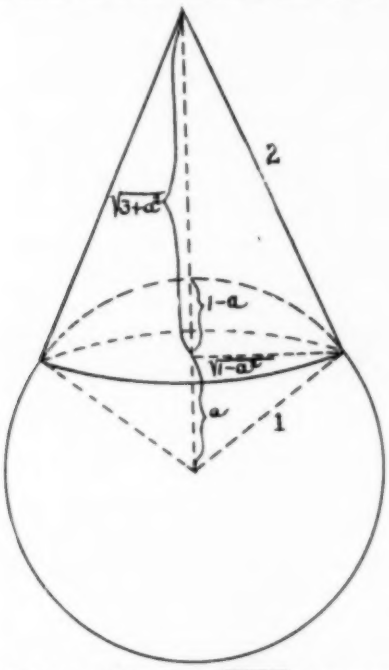
Also solved by *Israel Wallach, Brooklyn, N. Y.; Louis R. Chase, Newport, R. I.;* and *M. G. Schucker, Pittsburgh, Pa.*

1105. *Proposed by Raymond Huck, Johnson City, Ill.*

A right circular cone formed by removing a sector from a circular disc of radius R is set on a sphere of diameter R, the volume included between the sphere and the cone being a maximum. Determine the number of degrees in the sector removed.

Solved by Louis R. Chase, Newport, R. I.

Let radius of the disc and the diameter of the sphere each be equal to 2. The line values in terms of a are shown in the figure.



Arc AOB $= 4$ pi $(360^\circ - x)/360 = 2$ pi $\sqrt{1-a^2}$, whence $x = 180(2-\sqrt{1-a^2})$

Since specified volume = volume double cone—volume spherical segment, $V = 1/3$ pi $(1-a^2)(a+\sqrt{3+a^2}) - (1-a)\ 2$ pi$/3$

Setting the derivative equal to zero and simplifying, we have the following condition for a maximum V,

$$21a^4+70a^2-27=0, \text{ yielding } a^2=0.3491439$$

Substituting this value for a in the expression for x above, and simplifying, $x = 214.7838$ degrees.

Also solved by *George Sergent, Tampico, Mexico;* and by *E. A. Hollister, Pontiac, Mich.*

1106.—*Proposed by the Editor.*

No solutions received. This is not a difficult problem. The area of the crescent is equal to the difference of a sector of a circle, center on the rim, two triangles, and a sector of a circle, center at center of the wheel. Answer, 38.22 in.

1107. *Proposed by the Editor.*

A 1 lb. sample of milk tests 3 1/2 per cent butter fat. How much cream, testing 35 per cent butter fat, must be added in order to bring the milk to a 5 per cent standard? (Do not use Algebra.)

Solved by Gerald Whittaker, Oakland, Calif.

Suppose that we have the right amount of cream in a pan. We pour the milk into the pan, mix, and pour off one pound of the mixture. This pound has gained .015 lb. of butter fat. The cream lost 30 per cent of its butter fat. Therefore, 30 per cent of the cream added equals .015 lb. Hence .05 lb. of cream must be added.

Also solved by *M. G. Schucker, Pittsburgh, Pa.; Howard H. Smith, Newburg, Iowa; George Sergent, Tampico, Mexico;* and by *E. de la Garza, Brownsville, Texas.*

1108. *Proposed by T. A. Bickerstaff, University, Miss.*

When I was born, my sister was 1/4 as old as my mother. She is now 1/3 as old as father. In four years, I shall be 1/4 as old as father. I am now 1/4 as old as mother. Which two members of our family have the same birthday?

Solved by Sudler Bamberger, Harrisburg, Pa.

Let a = my present age, s my sister's age, m mother's age, and f father's age.

$(m-a)/4 = s-a$; $3s = f$;

$(f+4)/4 = a+4$; $m = 4a$;

$f+4 = 4(m/4+4)$; $f-m = 12$;

$m - m/4 = 4(f/3 - m/4)$; $21m = 16f$.

Hence, $m = 38\ 2/5$, and $f = 50\ 2/5$.

Father is 20 years older than mother, and both have the same birthday.

Also solved by *Floyd Sheel, Assaria, Kansas; F. P. Hennessey, Jamaica Plains, Mass.; Leta Randall, Atwood, Ill.; O. K. Defoe, Clarksville, Ark.; Howard H. Smith, Newburg, Iowa; O. J. Richiardi, Chicago, Ill.; Raymond Huck, Johnston City, Ill.; E. de la Garza, Brownsville, Texas; E. A. Hollister, Pontiac, Mich.; Hazel Estelle Fliess, Clifton Forge, Va.; Adolph Weinstock, Philadelphia, Pa.; Alice M. Barkhuff, Cathlamet, Wash.;* and the *Proposer.*

PROBLEMS FOR SOLUTION.

1115. *Proposed by I. N. Warner, Platteville, Wis.*

A right circular cone of altitude 10 in. and radius of base 6 in. is cut by a plane through the vertex making a section equal in area to only one-half of the area of the largest possible section through the vertex. How far from center of cone's base does this section cut the base?

1116. *Proposed by Norman Anning, University of Michigan.*

Find the angles satisfying this equation:

$$\sin^2 X - \sin X = \sin^2 18° - \sin 18°.$$

1117. *Proposed by H. D. Grossman, Brooklyn, N. Y.*

Given triangle ABC with angle bisectors BR and CS. Drop perpendiculars AU on BR and AV on CS. Then UV is parallel to BC.

1118. *Proposed by John J. Kinsella, Monticello, N. Y.*

Simplify: $$\left[\sqrt[4]{\left(-\frac{8}{27}\right)^{-3/3}}\right]^{-3/3}$$

1119. *Proposed by the Editor:*

The area of a rational right-angled triangle cannot be equal to a square.

1120. *Proposed by William Bashfield, Walla Walla, Wash.*

Given the quadrilateral ABCD with diagonals AC and DB. Of this quadrilateral let there be known the sides AB, BC and the angles X = ADB and Y = CDB. Find AD, DC, and DB.

WORLD RELATIONS IN THE GEOGRAPHY CLASS.

HELEN A. SOUTHGATE,

High School, Michigan City, Ind.

In one of the opening chapters of "Dependent America," Ex-Secretary Redfield says: "——believing that if and when it is realized by the average citizen that his life and the lives of his children are tied by bonds of mutual interest and service to the men and women of every land, a great step forward will have been taken toward the peace of the world." It is clearly the duty as well as the opportunity of the geography teacher to impress upon his pupils these interlocking interests of the various nations.

One of the most effective methods to this end I have found to be a study of everyday relations, beginning, perhaps, with the geography of the breakfast table. Probable sources of the various foods are plotted on maps of the world or of the United States. Lines drawn to our home city emphasize the local relationship. Geographic reasons for these sources are discussed. Competitive sources are also discussed, such as Danish butter on the New York market and New Zealand butter in San Francisco. Climate, labor conditions, and transportation problems are all involved. Dishes, silverware and table linen may be included.

Just before Thanksgiving we studied the sources of the Thanksgiving dinner, with Texas turkeys competing with home grown fowls, Cape Cod or Wisconsin cranberries, nuts from the Parnahyba valley in Brazil and from California, currants and citron for the plum pudding from the Mediterranean. By the time we have studied all the foods used in the various homes for the Thanksgiving meal, we have travelled from the equator well toward the poles and through most of the 360 degrees of east and west longitude.

At Christmas time ropes of red and green "friz" made in Japan vie with ruscus from Italy to add brilliancy to the holiday decorations. The ruscus, by the way, is dyed in the neighboring city of LaPorte, Indiana, which has one of the largest factories in the world for that purpose. A study of sources of Christmas trees and Christmas greens introduces the importance of conservation. An ex-

hibit of natural and artificial decorations is very interesting. Here artificial mistletoe and holly "made in Germany" met the real plants from Texas and Oklahoma.

The geography of Christmas presents is a far-reaching subject, for Christmas presents include almost everything that is made. The newspapers furnished some excellent material for posters of fur coats; purses, scarfs and gloves; china; jewelry, etc. Woolworth's and the A&P, department stores, hardware stores and gift shops all yielded excellent geographic material.

We also tried to keep track of the vegetable and fruit markets, where we learned many interesting and surprising things. Many a "why" is still unanswered. For example, why were California asparagus and home grown sold here on the same day last spring? Why onions in February from British Columbia? (I have the A&P tag in my possession, brought by one of the boys to satisfy my scepticism.)

There is really no end to the interesting topics that come up. I should like to see a whole year's work developed entirely from the home city as a center, including everything made or sold within its limits, and its excursions into other parts of the world; workmen sent to Argentina to build chimneys in Buenos Aires, agents scouting for lumber or timber lands, and all the fascinating world contacts passing unnoted in every community.

It is obvious that the textbook will be entirely inadequate for this work. "Dependent America" is very useful, but newspapers and magazines are esesntial if the work is to be up-to-date. The Mid-Pacific Magazine, published in Honolulu, and the Bulletin of the Pan-American Union, published in Washington, D. C. are very helpful, but the best material is found in the Weekly Commerce Reports, published by the United States Department of Commerce. Every number contains some articles which are exactly what you need for certain subjects. Illustrated articles on lac and on the production of tung, or China wood-oil in Florida are useful when studying varnishes and enamels. Other articles contain that element of human interest so important for international understanding. Among these is a recent article on sports in Western Mexico. It contains the surprising information that when, on two occa-

Q. E. D.

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sions this last year, a baseball game and a bull-fight were scheduled for the same afternoon, the baseball stadium (Yes, they have stadiums, there) was packed, and the bullfights did not make expenses. The article is illustrated with a picture of one of the girls' baseball teams of Mazatlan.

In addition to the main articles, which cover the whole range of foreign commerce and poke into the most remote corners of the globe, there are the ever-fascinating "Trade Opportunities" with which each week's issue ends. All sorts of places one never heard of before are wanting all sorts of things. Other places associated in most minds with weird, barbaric customs, are asking for the most ordinary things of our everyday life. Last week Addis Ababa wanted canned fruits, fish, tires and inner tubes. Soerabaya wants bedsteads, typewriters and sporting goods. Not only are the grownups of Soerabaya to enjoy modern recreation; the little, brown-skinned Soerabayan children will soon be racing up and down the palm lined streets in tricycles and velocipedes. Bangalore wants machinery for making peppermints; Singapore longs for pickles. Cairo, Egypt, tired at last of the plagues of Moses, demands flyswatters. Can openers and paper plates and spoons certainly suggest picnics in Johannesburg, South Africa. Even the canny Scot has his little surprise for us. Glasgow has turned its back on oatmeal and is demanding other breakfast foods.

All these, and many more, may be obtained for a four dollar a year subscription to Weekly Commerce Reports.

COOPER ORNITHOLOGICAL CLUB.

The fifth annual meeting of the Cooper Ornithological Club will be held in Los Angeles on Friday and Saturday, April 11 and 12. If enough visitors register for field trips, an outing will be planned for Sunday, the 13th.

Morning and afternoon sessions will be held in the Los Angeles Museum, Exposition Park, where facilities are available for the projection of either motion pictures or lantern slides. Evening entertainment will be announced on the opening day.

Members or guests who plan to present papers will confer an obvious favor on the committee by making as early a return as possible on the self-addressed card attached.

The interested public is cordially invited to attend the sessions, and guests of members are welcomed to the evening sociability.

THE COMMITTEE.

THE UNICLOK.

Science has designed mechanical men, or robots, that see, hear, talk, and perform useful tasks; science has copied and even improved upon the sun by means of the ultra-violet ray machine, making summer where winter is; it has imitated nature in the process of mechanically purifying the atmosphere; through the discovery of synthetic rayon, it has imitated nature in the production of textile materials; science has, in fact, duplicated and surpassed natural phenomena countless times. Now man's ingenuity has created a mechanical world, a sort of miniature Mother Nature that goes through all its temporal antics before your eyes.

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The Uniclok looks like an ordinary school or scientific globe, with an electric Telechron clock in its base. An electric bulb inside the terrestrial sphere reflects light and shadow on the outside surface, which indicates day and night in the hemispheres and shows the seasons in the various quarters of the earth. A motor-operated fixture automatically depicts the changing position of the earth relative to the sun, affords current information about the rising and setting of Old Sol, the time, and the hours of light and darkness any where, any time. The globe rotates on its axis once daily. The date of the year any place on the earth is also shown.

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Teachers of Biology—Ask these questions of your pupils and see what *they* say. (The following questions may sound foolish, but, if they do, to you, read "Instinct and Intelligence" by Major R. W. G. Hingston and then send in your answers.)

550. Is an insect a *rational being?*

1. Can it *reason* from cause to effect?
2. Can it *adapt* means to ends?
3. Can it *reflect* on a course of action?
4. Can it do something *ingenious?*
5. Can it act with *judgment?*
6. Can it show *resourcefulness?*
7. Can it act with *forethought?*
8. Can it *remember?*
9. Can it *imitate?*
10. Can it learn from *experience?*

HELP, PLEASE—CHEMISTRY.

551. Will you kindly solve the following problem for the chemistry students at Bishop McDonnell Memorial High School, Brooklyn, N. Y. *The atomic weight of bismuth is 208.6 at 1640° C; the average molecular weight of bismuth is 293. What per cent of the molecules of Bi_2 have been dissociated into Bi?*

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Very respectfully yours,
Chemistry Students, E77C72,
per LILLIAN SCOTT.

HIGHRITER'S TESTS IN PHYSICS.

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552. *Contributed by Gordon E. Highriter, G. A. R. Memorial High School, Wilkes-Barre, Pa.*

This year in the study of magnetism and electricity in our elementary physics course we used completion tests. As these tests worked well in our department I thought I would send copies to you.

The titles of the tests refer to the titles of the chapters in Fuller-Brownlee and Baker's Elementary Principles of Physics, which we are using. I see no reason, however, why these tests would not be as satisfactory with other texts as they were made to cover a subject and not to fit our text.

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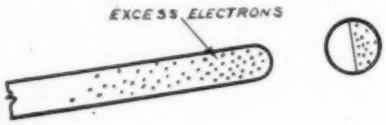
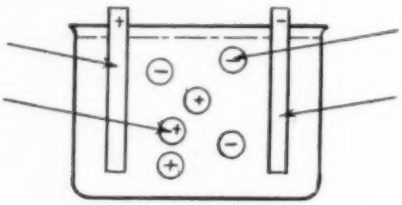
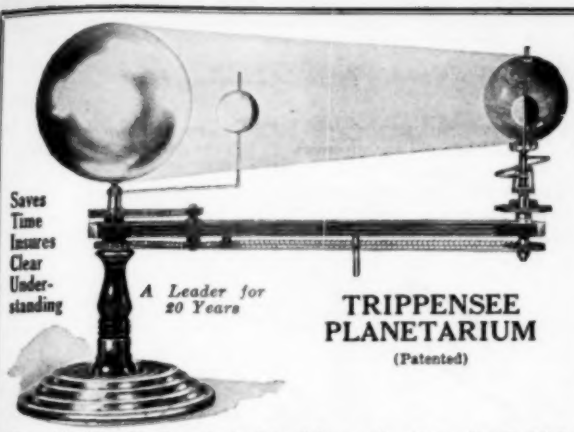
(1) The man who named these charges was .....
(1) The device for detecting these charges is called an .....
(2) Every atom consists of a nucleus containing an excess of .... electricity, and from one to ninety-two ..... moving around this nucleus.
(4) Number in order the following steps to be taken in charging an electroscope by induction: (.....) Touch the knob of the electroscope with the finger (.....) Bring a charged body near the electroscope. (.....) Take away the charged body. (.....) Take away the finger.
(5) In the diagram, mark polarity and fill in the blanks. The process is called .....



(1) A condenser stores up .....
(3) An electric current in a wire consists of a stream of electrons driven through the wire from ..... to ..... by an ..... force.
(1) Substances that conduct electricity when in a water solution are known as .....
(1) The permanent separation of such a substance into its constituents by the passage of an electric current is called .....
(4) Label the four arrows.



(2) An electric cell is a device for converting ..... energy into ..... energy.
(1) The man who discovered that this could be done was an Italian named .....
(2) In the dry cell the positive electrode is made of ..... and the negative of .....
(3) In this cell polarization is prevented by surrounding the positive electrode with ..... This gives off ..... which unites with the hydrogen and forms .....
(2) Storage cells store ..... not .....
(2) Two types of storage cell are the ..... storage cell and the ..... storage cell.
(5) Three cells each having an E. M. F. of 2 volts and an internal resistance of three-tenths (0.3) ohm, are to be used with an external resistance of one-tenth ohm (0.1). When the cells are connected in series the current is ..... amperes. When the cells are in parallel the current is ..... amperes.
(3) Whenever a wire is moved across a magnetic field an E. M. F. is generated in the wire. This principle was discovered by .... and also by ..... The principle is called .....



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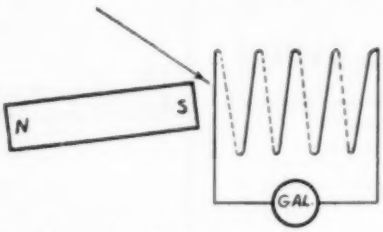
(2) In any electric generator the current in the field magnets must always be ..... current. The current in the armature is always ..... current.
(1) In a direct current generator the brushes take the current from a split ring called a .....
(3) Connect this generator as a shunt generator so that it will furnish current to the lamps.

(2) An electric generator is a device for changing ..... energy into ..... energy.
(2) An electric motor is a device for changing ..... energy into ..... energy.
(3) Mark magnetic polarity at end of arrow. Magnet is moving toward the coil.



(1) The law illustrated here is called ..... law.
(2) Induction coils are used to ..... the voltage of ..... electric current.
(1) The current flowing through the telephone transmitter is ..... current.
(1) The current in the telephone receiver is ..... current.
(3) A transformer has 6000 turns in the primary and 400 turns in the secondary. The primary voltage is 1500; the secondary voltage is .....
(3) If the primary current is five amperes the secondary current will be ..... amperes.

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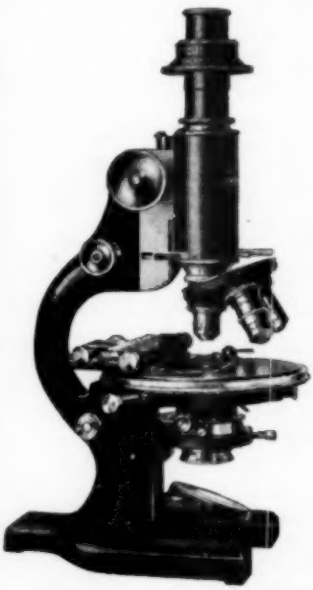

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BOOKS RECEIVED.

Animal Micrology by Michael F. Guyer, Professor of Zoology in the University of Wisconsin. Revised edition. Cloth. Pages xi+289. 15x22 cm. The University of Chicago Press, Chicago, Illinois. Price $3.00.

Educational Problems for Psychological Study by Goodwin Watson, Associate Professor of Education, Teachers College, Columbia University and Ralph B. Spence, Assistant Professor of Education, Teachers College, Columbia University. Cloth. Pages xii+352. 13x20 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.80.

Survey of College Entrance Credits and College Courses in Music. Prepared by the Research Council of the Music Supervisors National Conference in cooperation with the National Bureau for the Advancement of Music. Cloth. Pages vi+209. 15x23 cm. 1930. National Bureau for the Advancement of Music, 45 West 45th Street, New York City. Price $2.00.

The New World of Physical Discovery by Floyd L. Darrow, Author of The Story of Chemistry, etc. Illustrated. Cloth. Pages 7+371. 15x23 cm. 1930. The Bobbs-Merrill Company, Indianapolis, Indiana. Price $3.50.

Eighth-Year Mathematics by Ernst R. Breslich, Associate Professor of the Teaching of Mathematics, The College of Education, The University of Chicago. Cloth. Pages ix+296. 12.5x19 cm. 1930. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.12.

Agricultural Mathematics by L. C. Plant, Professor of Mathematics. Michigan State College. First Edition. Cloth. Pages ix+199. 12.5x18.5 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $2.50.

Elementary Science by Grades Book One by Ellis C. Persing, Chairman of the Department of Science in the School of Education, Western Reserve University and Elizabeth K. Peeples, Principal in the Washington, D. C., Public Schools. Cloth. 128 pages. 12.5x19 cm. 1930. D. Appleton and Company, 35 West 32nd Street, New York. Price 72 cents.

Outlines of Economic Zoology by Albert M. Reese, Professor of Zoology in West Virginia University. Third Edition with one hundred ninety four Illustrations. Cloth. Pages xxi+323. 13x19.5 cm. 1930. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $2.50.

Economic Geography by R. H. Whitbeck, Professor of Geography, University of Wisconsin and V. C. Finch, Professor of Geography, University of Wisconsin. Second Edition. Cloth. Pages x+565. 15x23 cm. 1930. McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York. Price $3.50.

Physiography Laboratory Sheets by Willard B. Nelson, Head of Department of Physical Sciences, Manual Training High School, Brooklyn, New York. 46 Experiments. 20.5x26.5 cm. Globe Book Company, 175 Fifth Avenue, New York. List Price Bound 80 cents, Class Price 60 cents. Looseleaf List Price 68 cents, Class Price 50 cents. Special Binder with Rings List Price 34 cents, Class Price 25 cents.

Junior American History Test by Harry J. Carman, Associate Professor of History, Columbia University, Thomas N. Barrows, History and Civics, The Lincoln School of Teachers College, Columbia University and Ben D. Wood, Associate Professor and Director Bureau of Collegiate Educational Research Columbia College, Columbia University. Form A and Form B have 12 pages each. Sold in packages of 25 with complete instructions at $1.30 net per package. World Book Company, Yonkers-on-Hudson, New York.

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Instructional Tests in Physics comprising twenty-five Tests in Mechanics, Heat, Light, Sound, and Electricity for High Schools and Colleges by Earl R. Glenn, New Jersey State Teachers College, Montclair, New Jersey and Ellsworth S. Obourn, John Burroughs School. Clayton, Missouri. List price of Instructional Tests in Physics is 32 cents for each student's booklet, 12 cents for Key and 16 cents for Teachers Manual. World Book Company, Yonkers-on-Hudson, New York.

Instructional Tests on Chemistry comprising thirty-six tests covering the various phases of the Subject for High Schools and Colleges by Earl R. Glenn, New Jersey Teachers College, Montclair, New Jersey and Louis E. Welton, John Hay High School, Cleveland, Ohio. List price of Instructional Tests in Chemistry is 36 cents for each student's booklet, 16 cents for the Key and 16 cents for the Teachers Manual. World Book Company, Yonkers-on-Hudson, New York.

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By Gifford Pinchot.

A forest is more than a collection of trees. It is not merely a wood storehouse. It is a wood factory, a water reservoir, a fish hatchery, a game refuge, and a wild-flower preserve. All these in one the forest truly is.

We are the biggest wood users on the face of the earth. The people of the United States actually use two-fifths of all the wood consumed in the world. I see no chance of an early abandonment of the wood-using habit. The way out of this situation is clear. We have been—and I hope we may continue to be—a nation of wood users, but to enjoy this privilege and the prosperity that goes with it we must become a nation of wood growers.

The biggest mistake made in the lumbering of the past was that no provisions were made for forest renewal. As a result we have vast stretches of idle forest land. It brings no good to anyone. It pays little or no taxes, keeps willing hands out of work, builds no roads, supports no industries, kills railroads, depopulates towns, creates a migratory population, all of which work against a good and stable citizenship. Idle forest land serves no one well. It is a menace to our normal national life.

We must do more than accept conservation. We must preach it and, what is most important of all, we must practice it. It is not enough to have a right attitude on this subject. For however right an attitude is, unless translated into action, little good will come from it.

If we act the part of good citizens we will bestow upon our children a wisely conserved heritage of natural resources. By doing this we will rear to ourselves a monument of noble vision and unselfish enterprise. Such a conservation policy will make this country a better land in which our boys and girls, and their boys and girls, can become the kind of men and women we want them to be.—*Department of Agriculture.*

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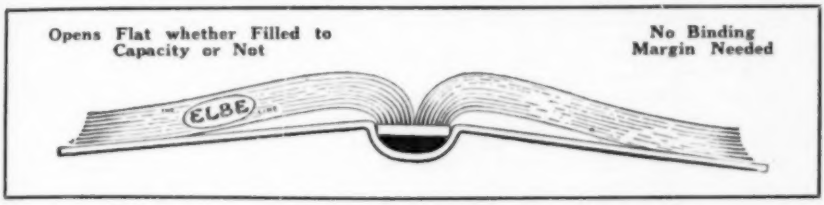

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BOOK REVIEWS.

Organic Evolution, by Richard Swann Lull, Sterling Professor of Vertebrate Paleontology, Director of the Peabody Museum of Natural History, Yale University. xix plus 743 pp. 265 figures. Revised Edition, 1929. The Macmillan Company, 60 Fifth Avenue, New York. $4.50.

While this work is comprehensive, covering the field in general, yet, the writer being a paleontologist, it is especially complete in its treatment of past life of our globe.

Of the 743 pages of the book, 168 are devoted to a development of a basis which makes possible the understanding of the evidences of evolution. A brief history of evolution is given. This is followed by chapters dealing with classification and distribution of organisms. Part II takes up the mechanism of evolution.

The discussions of the evidences of evolution are particularly rich in illustrations taken from living plant and animal forms and from fossils. More than 300 pages of the bokk are devoted to evidences from paleontology. The mass of information given in this connection is unusual for a book of this type. One is impressed with the great amount of material which only paleontology can furnish.

The book is suitable and highly valuable for a text in college classes, for use as a reference work for the teacher of the biological subjects in high school, and for general reading. After this reviewer started on the book, he had a desire to read it through, page by page until it was finished.

Jerome Isenbarger.

Backgrounds of Biology, by John Giesen, Sc.D., Director of the Department of Biology, St. Thomas College, St. Paul, Minn., and Thomas S. Humphrey, A. B., Assistant Professor of Biology, Holy Cross College, Worcester, Mass. x plus 278 pp., 66 figures. The Bruce Publishing Company, Milwaukee, Wis. 1929.

This book grew out of a course in biology which has been given for students who find it impossible to take a standard laboratory course in the subject. The book is unique in that it is adapted to this unique course in biology which is given one hour each week throughout the junior year of college.

If this type of biology course is desired, it would seem that the emphasis is well placed. Five chapters are devoted to a consideration of the cell as the unit of structure and of function. Four chapters are used in discussing the subjects of heredity and eugenics, two are given to evolution and origin of life. Two chapters deal with bacteria, infection and immunity. Three chapters are devoted mainly to human physiology, and the final chapter takes up animal psychology.

The work is presented in clear-cut, non-technical language, well adapted to the student or general reader whose training in science is limited.

Eugenists, as a rule, would not agree with the authors in the position taken that there is grave doubt whether feeble-mindedness is inheritable. Menge, in his General and Professional Biology states, "Goddard proved feeble-mindedness a unit character." As such, it would come under the Mendelian Law. As to organic evolution, the authors take the position that whatever its value as a working hypothesis may be, it is certainly neither a scientific principle nor a fact established beyond all reasonable doubt. Most biologists, in the opinion of the reviewer, consider organic evolution something more than a philosophic axiom or principle arrived at by deductive reasoning, alone.

Jerome Isenbarger.

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Second Course in Algebra, by Fred Engelhardt, Ph.D., Professor of Education, University of Minnesota, and Leonard D. Haertter, M.A., head of the Mathematics Department, John Burroughs School, St. Louis, Mo. Cloth. Pages viii+423. 1929. The John C. Winston Co., Philadelphia, Pa.

This Second Course in Algebra is intended to follow the Authors' First Course in Algebra, but may be used equally well with any first-year algebra text as there are presented in the text three chapters of review materials which take up the fundamental concepts, processes and principles usually treated in a first-year course. The significant features of the text are:. (1) *Functionality:* Chapter V is devoted to an adequate treatment of direct, inverse, and joint variation and throughout the text the concept is stressed through the use of the graph and the formula. (2) *Presentation:* the method used in the presentation and development of the algebraic concepts is psychological, the illustrative materials and exercises providing ample opportunity for the formulation by the pupils, of the nature and meaning of the concept. (3) *Instructional Materials:* problems and exercises are well graded and are based upon the associated topics in arithmetic, algebra, and geometry. (4) *Evaluation of Learning:* various types of testing materials are presented throughout the text which can be used not only as instructional materials but also for the purpose of preview, diagnosis, and evaluation of instruction. J. S. Georges.

Plane Geometry by Charles Solomon, Chairman of the Department of Mathematics, Boys' High School, Brooklyn, N. Y., and Herman H. Wright, District Superintendent assigned to High Schools, New York City. Cloth. Pages viii+340. 12x18.5 cm. 1929. Charles Scribner's Sons, 597 Fifth Avenue, New York. Price $1.40.

In the main, this new text is organized along the traditional line of "Books" of Plane Geometry. The five books are preceded by a brief introductory chapter on the subject matter of Geometry, why it is studied, the nature of a proof, some fundamental axioms and definitions, and preliminary exercises. The appendix contains such topics as external division, mean and extreme ratio, and the trigonometry of the right triangle.

There are several distinctive features of the text. Among them are:

1. The proof of each proposition is preceded by an analysis, or a plan of attacking the proof or both.

2. Scattered through the text are 17 groups of exercises of the new type—true-false, completion, and multiple choice.

3. At the end of each book are numerous miscellaneous exercises that are applications of the preceding theorems. These are followed by practical problems drawn from the fields of surveying, engineering, architecture, physics, mechanics, and shop practice. The text contains a total of 1,098 exercises.

4. There is an excellent treatment of the subject, "How to Attack Originals."

5. The solution of construction problems is given a splendid exposition accompanied by much practice material.

6. The section on Loci is simple but quite adequate.

Throughout the text, angles denoted by Arabic numbers rather than literal numbers. The 14 lines denoted to the subject-matter and uses of geometry are hardly sufficient to give a pupil much of a conception of the subject he is about to study.

On a whole, the text is an excellent one and merits the serious consideration of geometry teachers. It should prove a very valuable text for beginning teachers. G. W. Hoge.

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The Making of Chemistry, by Benjamin Harrow, Author of Romance of the Atom, Eminent Chemists of Our Time, Glands in Health and Disease, etc. "A History of Chemistry for the layman with no professional knowledge of the subject, told largely in terms of the personal activities of great chemists, with special emphasis on modern industrial chemistry and its contribution to the intellectual and material development of our times." First edition. pp. viii plus 223. 14 x 20 x 2.5 cm. Cloth. 1930. $2.00 The John Day Co. New York.

While this story of the development of the science of chemistry is written primarily for the layman it is nevertheless worthy of close study by the teacher of chemistry. The latter will not have the difficulty that the layman may expect from the technical side of the subject and will be free to take in and appreciate the skillful presentation of the history of chemistry, the biography of the great pioneers and leaders of the science and the background of contemporary political, scientific and intellectual history against which the author has drawn his chemical history.

Secondary school students of chemistry may well be given access to the book as a reference text not only for the historical setting but also for its clear presentation of the essentials of a number of outstanding topics in chemistry, notably the Atomic Theory, the Avogadro Hypothesis, the Periodic Law and the electrolytic dissociation theory. The latter part of the book with its chapter topics such as "The Curies and Radium", "Chemistry in Medicine", and the four chapters on Chemistry in Industry with Coal, Petroleum, Iron, Cellulose, Photography and Catalysis should also prove to be interesting reading for high school chemistry pupils. The book should be a welcome addition to any high school chemistry library. F. B. W.

Animals Looking at You, by Paul Eipper, Art Director for a publishing house in Berlin. Translation by Patrick Kerwain. 163 pp. 32 illustrations from photographs. The Viking Press, 18 E 48th St. New York. 1929. $3.00.

This is a book in a class by itself. As a lover of animals, the author has gained an intimate acquaintance with wild forms in captivity by winning their confidence. Stories are told of personal experiences that the author has had during his daily visits to the Berlin Zoo. In fact, the book is a collection of true animal stories, there being no definite thread of thought running through the book. This feature may be illustrated by a random selection of a few consecutive headings, as follows: "The Cheetah Rejoices," "Giraffes at Play," "The Night Ape is My Friend," "The Jealous Lion." The stories are delightfully told and the illustrations are unusual. This book can be highly recommended for general reading or for supplementary work for biology classes.

Jerome Isenbarger.

Solid Geometry, by William W. Strader and Lawrence D. Rhoads, of the Wm. L. Dickinson High School, Jersey City, N. J. Pages viii+170. 13.5x19 cm. 1929. The John C. Winston Co., Philadelphia, Pa.

The authors have written this text with the same care that they gave to the writing of their Plane Geometry. From the beginning to the end it is a work of art. Its beautiful figures, clear type, and open paging give it an attractive appearance.

The choice of propositions meets the requirements of both the National Committee and the College Entrance Board. There are numerous miscellaneous propositions and abundant exercises which make it possible to accommodate students of different grades of ability. J. M. Kinney.

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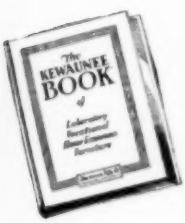

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Vocational Mathematics, by Edgar M. Starr and Edwin G. Olds, Assistant Professors of Mathematics in the Carnegie Institute of Technology. Pp. x+184. 13x19.5 cm. 1930. P. Blakiston's Son & Co. Inc. Philadelphia, Pa. Price, $1.25.

This book is designed to give the student, who has had some training over all or part of the material contained in the text, an opportunity to review the fundamental processes involved in practical applications.

The material is not confined to any particular trade as the authors have been guided by the principle that the same fundamental truths underlie the calculations required in all of the trades. While no attempt is made to treat all the problems of any trade, many important applications to the various trades are emphasized.

The book is divided into two parts. Part one is devoted to the arithmetic needed in the trades and part two deals with the Algebra, Geometry, and Trigonometry that is required. The authors have also included a number of problems of business, and of social significance. The book is attractive and well done.

C. A. Stone.

High School Science Terminology, Chemistry and Physics, by J. O. Frank, Professor of Science Education, Wisconsin State Teachers College, Oshkosh, Wis., and H. K. White, Science Department, Mussoula County High School, Montana. Pp. 204, 9" x 6". Copyrighted and published by J. O. Frank. Price $2.50.

This is a dictionary of over 800 terms with which the student will come in contact in his study of high school physics and chemistry. Over 400 of the terms are exclusively chemical (sapenify, aldehyde), some 200 terms pertain to the field of physics (electrostatic capacity, capillarity), while the remaining 200 odd terms are common to both fields (spectrum, solubility). The authors take the attitude that there is need for such a compendium in the first place because a step should be taken in the direction of standardization of scientific term meanings. Responsibility is placed on text-books for a looseness in the use of scientific vocabulary that results in confusion in the high school student's mind. In the second place they claim that an effort should be made to discriminate between the meanings of the same words in the different fields of science. And finally, there should be available to the high school student a book that lies between the inadequate abridged dictionary and the cumbersome unabridged dictionary which gives many meanings with which the student has no immediate concern. The book is more than a dictionary in the popular sense, for in many instances facts and relations are given beyond the mere necessity of definition. As a matter of fact, some terms like *ionization, steel* and *light* receive more than a page of attention. The material is obtained from authentic sources.

R. B. Z.

Elementary Laboratory Aerodynamics, by Arthur L. Jordan Science Department, Polytechnic High School, San Francisco, California. Paper, Pp. 67. 15x21.5 cm. 1929, $.80 Ronald Press Company, New York.

This is an actual working manuel written to the level of the student. It is concise and clear. The points driven home are essentials —not merely theoretical or conventional pieces of work. Twenty-one experiments are outlined. About half of these can readily be substituted for regular physics experiments now offered. Forces Producing Lift; Density of air; and centrifugal action are good examples. Other experiments are strictly typical of aviation. They are simple and inexpensive and should be of interest as physics projects or as demonstrations for aviation clubs. The experiment on Wind Tunnel; Wing Lift and Drag is an outstanding example of this type. This

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The Mathematics of Investment, Revised, by William L. Hart, Ph.D., Professor of Mathematics in the University of Minnesota. xii+253+88 pages. 14.5x21 cm. 1929. D. C. Heath, Boston. Price, with tables, $3.52; without tables, $2.60.

The text is divided into three parts: 1. Annuities Certain; II. Life Insurance; III. Auxiliary Subjects. Compound Interest and Annuities Certain have been completely rewritten. This edition presents a flexible arrangement which makes it possible to give courses ranging in length from three to six hours. There is a wealth of material from which topics and problems may be selected to match the varying abilities of students.

J. M. Kinney.

YALE DEPARTMENT OF EDUCATION ANNOUNCES NEW PLAN OF STUDY.

New Haven, Conn., March 8—A new plan of study in the Department of Education of Yale University, to be introduced next fall, was announced today by Professor Clyde M. Hill, Chairman of the Department. Under this plan, a group of graduate students, working for the M.A. or Ph.D. degrees, limited to fifty in number, will be selected with especial reference to their intellectual maturity and capacity for independent thinking. This group will be given freedom from conventional courses and credit requirements; will be completely separated from extension or undergraduate students and will have at its disposal practically the full time of seven members of the faculty—four professors, one associate, and two assistant professors. Additional members of the Department of Education and other departments of the Graduate School of the University will be available for work in special fields.

"For many years students of education have felt that in practice there is little to differentiate graduate from undergraduate instruction." Professor Hill said today in commenting upon the new plan. "Graduate degrees are earned largely by the accumulation of credit in courses conducted by undergraduate methods. Students in many American universities spend two full years of a three-year program of graduate study merely in satisfying course requirements. Not only are undergraduate methods employed in a majority of our graduate schools but very frequently the class work of graduate students is carried on in classes in which the undergraduate enrollment predominates. The ease with which advanced degrees can be obtained has stimulated a great increase in the enrollment in graduate schools throughout the country. The demands made by many students, who are more interested in advanced degrees than they are in advanced study, have forced gradute schools to resort to methods of instruction that actually deprive students with exceptional talents of the opportunity to apply their time and abilities advantageously. They must devote themselves to making the hurdles that have been set up for the larger group. It is to provide for the intellectually mature students that the Department of Education has devised its new plan of graduate work."

The plan will allow extreme flexibility of program and conditions imposed for the purpose of affording each student in the group the maximum of opportunity to apply his time and abilities most advantageously. No student will be required to go through any routine of study covering what he has already mastered. A general seminar, enrolling approximately twenty-five students and from six to eight faculty members, will hold two-hour sessions each week. This semi-

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Fifteen teaching fellowships, ranging in value from $500 to $1,800, and totaling $15,600, will be available for suitable candidates in the Department of Education for next year.

The Department of Education, Professor Hill said, will continue to offer courses to Connecticut teachers, and expects to improve this part of its work by increasing the range of available courses and by revising courses which are now offered, so that they will better meet the needs of these teachers.

"PARROT DISEASE" NOT NEW.

Psittacosis has been prominent in the news for weeks, following the diagnosis of an illness in Maryland as "parrot's fever." The "parrot disease," so called, is a novelty to physicians of the United States, although it is by no means new to medical science. With symptoms strongly resembling pneumonia and typhoid fever, psittacosis has presented difficulties in accurate diagnosis. Doctors have assured the public, incidentally, that the disease is rare, and that there is no danger of an epidemic.

The "parrot's fever" has been known for many years as a disease of the Psittaci or, as the order is usually called, Psittaciformes—the zoological order to which parrots belong. The name of the order, according to Webster's New International Dictionary, comes from the Latin word 'psittacus," meaning a parrot; the Latin word is borrowed from the Greek, Psittacosis is formed in the same way, from "psittakos," meaning parrot, and "-osis," a Greek suffix used in medical works to mean "an abnormal or diseased condition." Psittacosis, therefore, from its derivation would mean a diseased condition in a parrot. This particular disease of parrots is communicable to man.

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